DIVISION OF THE HUMANITIES AND SOCIAL SCIENCES
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA 91125

THE DESIGN OF MECHANISMS TO ALLOCATE SPACE STATION RESOURCES*

Jeffrey S. Banks
University of Rochester

John O. Ledyard
California Institute of Technology

David P. Porter
Jet Propulsion Laboratory

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ABSTRACT

This paper demonstrates the use of applied organizational design to investigate possible mechanisms to allocate the resources of Space Station. First, a specific laboratory experimental environment (testbed) and baseline policy are developed using the salient technical features of the Space Station and past Space Shuttle experiences. The use of priority contracts to assist in contingent rescheduling of resources due to supply curtailments is established. Next, generalized versions of an English auction and Vickrey-Groves type sealed bid auction are designed and developed to allocate scheduled resource use and priority. Finally, these mechanisms are tested and evaluated in the testbed. The data demonstrates that the expected efficiency increases significantly using the auction mechanisms rather than allocations from first-come-first-served processes. However, the auction mechanisms do *not* produce outcomes near the 100% level of efficiency. Several results are dedicated to the revenue generating properties of the mechanisms and individual bidding behavior.

Key Words: Mechanisms, pricing, uncertainty, fitting, experiments, priority, scheduling, auctions.

JEL classification numbers: 022, 026, 215.

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I. INTRODUCTION AND METHODOLOGY

In this paper we report on a part of our investigation into possible resource allocation policies for the earth-orbiting space station which has been proposed by the National Aeronautics and Space Administration (NASA). This is a problem in "applied organization (mechanism) design" which requires a combination of methods from theory, history, and experimentation. The output of this research includes descriptions of two possible mechanisms, some of their theoretical properties, and measures of their performance in an appropriately designed "testbed" environment.[1] The evidence indicates that these are feasible designs, they will allocate resources, and that their performance is superior to "traditional" procedures. We do not feel that this concludes all testing or that either mechanism has been developed to the point at which it could be instantaneously implemented. We do, however, think these two are the best prospects for continued development.[2] The details of the mechanisms, the testbed, and the performance measures are provided so that others can try to improve on our efforts.

Since this type of research is new and unfamiliar to many, we provide a guide to the path we took to answer the question: In what way should it be decided how resources on the space station are to be allocated? The process involved a complex interaction between theoretical, experimental and historical methods to understand new processes and their relationships to existing ones. We summarize it in six steps. First one has to identify the real problem to be solved. This involves discovery of the salient features of the space station, its environment, the players, and the performance expected of any organization chosen to allocate resources. This process results in a generic model of the problem. The second step requires identification of current policies in use or under consideration by NASA, an extensive review of policies or mechanisms that have been proposed for similar generic problems, and the preliminary development of any new organizational design concepts that seem appropriate. Third, based on these generic models and the understanding of current policies, a specific testbed (a laboratory experimental environment) is created and a baseline mechanism (mimicking the important features of current policy) is modeled so that the performance characteristics of other mechanisms can be evaluated in a sensible fashion. Fourth, specific mechanisms are created. This later step includes the necessary transformation of a theoretical description of a mechanism into an operative process: a language and a set of rules for information processing and communication among participants, stopping rules, etc. In short, the game form has to be converted to procedures that will operate at least in the testbed environment. Fifth, experimental observations are generated, the specific mechanisms are redesigned to correct for any anomalies in performance which the testing uncovered, and the environment is adjusted to make the testing even more rigorous. The sixth and final step involves the analysis of the data, the reporting of the performance results and a listing of recommendations for further design and testing.

The end result of this systematic approach to the design of an organization was, in our case, two potential mechanisms which performed satisfactorily and which are now ready for further development.

The paper is organized as follows. In Section II, the space station allocation problem, which led to this research, is portrayed. In Section III we recount the history of past practice and describe some of the literature on past research that might apply. This section is intended to provide information for the reader on the current state of the art in theory and in practice. Sections IV to VII contain descriptions of the mechanisms we have designed, how we evaluated them, and the data from those efforts. In Section VIII, we provide a terse summary of what we have learned both about policies for the allocation of resources on the space station and about the efficacy of our methods.

II. THE SPACE STATION ALLOCATION PROBLEM[3]

The space station is planned to be an integrated facility of subsystems providing a variety of services (e.g. data management, manpower, pressurized volume) to users over time. The possible users of this facility are civil U.S. government, Department of Defense, commercial entities, universities, foreign governments, etc. Furthermore, the station itself will be a user of these resources, in that each subsystem requires inputs from other subsystems for operation and maintenance. The space station can be thought of as a non-linear input-output model among its subsystems. In addition, the space station will be a pioneer project with many new and untested technologies rendering the technical relationship among the subsystems uncertain (see Banks, Ledyard, and Porter [1986] and Fox and Quirk [1985] for details). This implies that the performance of the station and the resources it will be able to supply will be subject to considerable uncertainty over its lifetime.

On the demand side, users will have to design and develop payloads which will consume station resources in varying degrees of intensity. In general, the demands for resources by payloads appear to be discrete (lumpy) and nonseparable (but not necessarily in fixed proportions). Thus, the overall space station allocation problem will involve the selection of users and the scheduling (manifesting) of payload demands within the uncertain operating capacities of the system. The processes by which allocations are chosen will affect payload design and the ultimate rewards from the use of the space station. (For a more extensive discussion of the space station allocation and decision-making problems, see Ledyard [1986]). To make things even more difficult, this manifesting problem must be performed with asymmetric information among the players.

In summary, the salient features of the problem are: (1) there are multiple users with widely divergent goals, which creates a *coordination and incentive problem,* (2) each user has private information about the benefits and costs of their possible scientific or commercial projects, which creates an *information problem,* (3) each user has a a small number of possible technologies for pursuing the desired ends of their project (demands are discrete and lumpy), which creates a *fitting problem,* and (4) the availability of resources for payloads on the space station will be uncertain (either payloads may fail and free allocated resources for other payloads or deliveries to payloads may be unreliable with extensive interruptions), which creates a *contingent scheduling problem.*

III. PAST AND CURRENT PRACTICE

A. Space Shuttle Policy

In an attempt to develop an appropriate mechanism for space station, one must assess current practice. The natural candidate in this case is past policy regarding the Space Shuttle-Space Transportation System (STS) allocation policy.[4] Our focus will be on the STS pricing policy and short-run allocation decisions. The stylized facts concerning the past policy toward STS users can be summarized as follows:

a) Payload requirements (weight, length, orbit, c.g., etc.) are given to Shuttle manifesters in the form of an application (Form 100).

b) System capabilities (performance envelopes, turnaround time, processing time, etc.) are determined by Shuttle supply managers and transmitted to manifesters.

c) Payloads are scheduled to Shuttles on a first-come, first- served basis in accordance with launch date requests, conditional on fitting within system constraints. However, priority is generally given to national security payloads and payloads with severe launch windows (these are referred to as *anchor points* in the manifest).

d) Compatibility assessments are made among the scheduled payloads via a "strawman" manifest which is then developed into a final manifest.

e) A set of standard prices are charged to non-NASA users (there are no internal prices for NASA-sponsored payloads) and are based on a predetermined level of the pro-rata share of "cost" depending on user class (commercial, DoD, civil U.S. government, etc.). Some limited provisions are made for negotiated prices (based on "cost") for optional services.

f) Remanifesting of scheduled payloads has been a common occurrence for the Shuttle because of launch delays. The past policy has used a fixed priority system for payload remanifests with priority based on origin of sponsorship. In particular, DoD has top priority with commercial paying customers next in line, and scientists last.

These stylized facts emphasize two important features of the allocation problem we confront: (1) it must be determined which payloads should be scheduled together (the *fitting* problem); and (2) the order of dispatch must be determined in those cases in which supply is different from the planned amount (the *contingent scheduling* problem). Our goal is to design mechanisms which perform these two functions in as (economically) efficient a manner as is possible.[5]

B. Approaches To Fitting

The problem of fitting resource demands into the capacity constraints of a system over time has been primarily attacked through the development of efficient algorithms to determine feasible solutions (See Reiter [1966, 1984] for a discussion on job-shop scheduling methods and related issues).[6] In our investigation of various NASA programs we found that considerable effort is expended on procedures to facilitate the scheduling problem. As one example, consider the procedure used by NASA to allocate its Deep Space Network (DSN) resources (the set of antennas, support facilities, and transmission times) to a set of spacecraft. The DSN resource allocation process takes resource requirements (view periods and tracking specifications) from the managers of spacecraft and then schedules resources (via a computer-based system) to spacecraft so as to maximize the ratio of total tracking time assigned (over all stations). (See Webb [1985] for a complete description of the DSN scheduling problem.) In this procedure, the initial plan is always characterized by the fact that activities are in conflict since requirements (demands) typically exceed system capabilities (supply). The conflicts among the users are resolved in a committee or by bilateral negotiations.

For Spacelab missions, instrument requirements are given to the NASA Payload Engineering Division (Code EM) where, for a "given flight or series of flights, selected instruments are grouped by discipline to provide for minimum interface requirements among experiments and maximum use of common facilities," (see the *STS Investigators' Guide*). Once a mission is selected, mission planning and resource timelines are developed by a committee of the selected users (this is called the Investigators Working Group-IWG) which is chaired by a NASA mission scientist. This group is to resolve conflicts in resource scheduling and contingent events (e.g. changes in instrument requirements, changes in STS performance, entry of new instruments in mission set) during the mission planning process. The IWG plans are transmitted to a mission manager who must coordinate the supply of Spacelab-STS services with experiment demands. The IWG tends to work by consensus and by bilateral agreements between parties in conflict. A flow diagram of the decision-making process for Spacelab missions is provided in Figure 1 in Appendix A. Considerable effort has been expended by NASA programmers to provide computer-based assistance in many of NASA's scheduling processes (including integer-programming algorithms and expert systems). However, no one has evaluated the performance of any of these with respect to efficiency—only with respect to feasibility.

The objective function of the scheduling process is usually based on some proxy for system utilization or on known payoffs. For the space station, a more complex approach to objectives is warranted. Given the diversity of the parties who will be using space station and given the asymmetry of information concerning benefits, the initial fitting of demands into resource constraints will require benefit information from users if efficiency is to be sought. That is, if the objective is to schedule efficient allocations, a decentralized process is required. Ressenti, Smith, and Bulfin [1982], have developed an approach, using a combinatorial auction mechanism that is oriented towards the efficient scheduling of landing and takeoff slots at airports. The mechanism solicits information via complicated contingent willingness-to-pay data (sealed bids). Scheduling is then performed by a computer-assisted market which finds the allocation giving the largest surplus (in submitted bids) for which the corresponding *conditional* bids do not violate the slot capacities.[7] They found that their mechanism does not result in demand revealing bids but efficiencies are consistently in the mid to high 90% levels. Furthermore, their mechanism generally results in higher efficiencies and fewer learning effects (low initial efficiencies) than a single sealed-bid auction for slots with an after-market for exchanges. Subsequent to this study, questions have been raised with respect to its efficacy and the robustness of its performance as the number of slots, airlines, and airports becomes realistic since a 0-1 integer programming algorithm is the heart of their mechanism.

C. Approaches To Contingent Scheduling

While the airport slot problem and corresponding combinatorial auction mechanism is a positive step towards solving the fitting problem, it does not assist in the replanning that will be needed because of the substantial uncertainty of supply inherent in the space station environment. It is obvious that to achieve efficient allocations, not only do we need information concerning net benefits in the use of planned resources, we also need information concerning losses or gains in surplus from adapting to changes in the planned use of resources. We are therefore interested in allocation schemes which not only assist in the allocation of resources (fitting of demands and resources) but also help in the reallocation of resources when contingencies arise.[8]

For the Shuttle, this situation has been handled by a policy of payload priorities based on origin (DoD, commercial paying customers) and anchor points (launch windows) instead of willingness-to-pay information (to direct efficient payload design). Such a policy has been a contributing factor in biasing lower-priority payloads towards smaller, easy-to-integrate, inefficient sizes, in order to minimize the opportunity costs of delay.

For a Spacelab mission, on-orbit replanning of the timeline was handled through a committee process of the users and chaired by the NASA mission scientist. In general, provisions for allocations due to subsystem failures, payload malfunctions, and "unique" opportunities were required. Dispatching procedures for each six-hour period were developed by the user committee and endorsed by the mission scientist.

The first instinct of most economists, when asked to solve this problem, would be to suggest the use of spot markets to reallocate resources. That is, wait until the available supply is known and then let prices clear the market. But this is not adequate here for two reasons. First, there will be long lead times between the design of payloads and their actual use of space station resources. It is therefore important to provide early guidance concerning reliabilities. Second, most of the resources are flows and have to be allocated over time before their total availability is known. When these difficulties arise, the typical alternative to spot markets is markets in contingent contracts such as insurance policies. We will concentrate our attention on a special type of contingent contract, called a priority contract.[9]

The economic literature on allocating priority is quite sparse. Harris and Raviv [1981] investigated (theoretically) various mechanisms for allocating resources when there are potential curtailments from uncertain demands on the system. They found that a monopolist could obtain his largest expected profit by segmenting demand on the basis of priority. Chao and Wilson [1985] developed a model of interruptible electric power which provides a theoretical justification for improvements in economic efficiency through the pricing of differing levels of priority service. Reitman [1985] provided a model of congestion-induced quality from service queues and the use of priority pricing to provide for spot markets for queue position. Banks, Ledyard and Porter [1986] demonstrated that traditional cost based pricing policies such as long-run marginal cost or cost-benefit studies cannot be relied upon to produce allocative efficiencies in an environment with net output uncertainty.

We will take from this literature the use of priority contracts. Our problem will then be the allocation of these contracts which will determine the queue position of individual demanders when resources are greater than or less than planned. These contracts simplify the reallocation procedure, and the prices for these contracts can provide both users and station managers with information concerning the costs and benefits of reliability.

IV. THE MODEL OF THE ENVIRONMENT

The first step in the design process is to model the class of environments within which users of the space station will operate. We adopt a stripped-down, stylized description modeled after the Space Shuttle environment which we feel captures most of the salient features of the problem including low supply reliability and the fitting of lumpy users.

A vector of resources, $\bar{y} \in R^{\kappa}$ is potentially to be supplied at times t_1 and t_2. $\Pi(t_i)$ is the probability $\bar{y}$ is supplied at t_i, and $1 - \Pi(t_i)$ is (then) the probability that $y = 0$ is supplied at t_i. This corresponds to the event tree in Figure 2.[10] There are $N = \{1, \ldots, n\}$ potential users of the resources. Each user has a set of feasible projects[11] $D_i \subseteq \mathbf{R}_+^{\kappa}$ and a (von Neumann-Morgenstern) utility function $u^i : D_i \times \mathbf{R} \rightarrow \mathbf{R}$ describing i's preferences over projects and his monetary payments b^i, where $\partial u^i / \partial b^i > 0$. Without loss of generality, let $u^i(0,0) = 0$.

The mechanism design problem, for this class of environments, can be split into two stages. First a collection of contracts is chosen; second, a method for allocating those contracts is designed. In the main body of this paper we explicitly consider only one set of contracts, based on priority, which are varied enough to enable the achievement of an efficient allocation in these environments. Information on complete contingent contracts is provided in footnotes. A *priority contract* corresponding to Figure 2 is a triple $\psi_i = (f^i, d^i, b^i)$, where $f^i \in \{1,2\}$ is a priority number, $d^i \in \mathbf{R}_+^2$ is a vector of resources, and $b^i \in \mathbf{R}_+$ is a monetary payment, paid whether resources are delivered or not. Define $K_f \subseteq N$ as the set of users holding a contract of type f. (Each user is assumed to hold only one contract.) We say that a collection $\Psi = (\Psi_1, \ldots, \Psi_n)$ of contracts is *feasible* if $\sum_{i \in K_f} d^i \leq \bar{y}, f = 1, 2$. Given a feasible collection of contracts, the actual allocation of resources is determined as follows: if $f^i = 1$, then user i receives d^i at t_1 if $\bar{y}$ is allocated at t_1, or d^i at t_2 if $\bar{y}$ is allocated at t_2 but not at t_1. If $f^i = 2$, i receives d^i at t_2 if $\bar{y}$ is allocated at *both* t_1 and t_2. Thus $f = 1$ is a "first priority" contract, in that all users holding these are allocated resources at the first available opportunity.[12]

Let $\rho_1 = \Pi(t_1) + (1 - \Pi(t_1))\Pi(t_2)$ be the probability that $\bar{y}$ is available at least once, and $\rho_2 = \Pi(t_1)\Pi(t_2)$ be the probability $\bar{y}$ is available twice. For any $d \leq \bar{y}$ and $b \geq 0$, let

$$d_i^*(d, b) = \underset{\substack{d_i \leq d \\ d_i \in D_i}}{argmax}\; u^i(d_i, b).$$

$d_i^*(d, b)$ would be the actual amount of resources consumed by i given a payment of b and a constraint of d. Then,

$$V^i(f^i, d^i, b^i) = \rho_f u^i(d_i^*(d^i\, b^i), b^i) + (1 - \rho_f) u^i[0, b^i]$$

is user i's expected utility for the contract (f^i, d^i, b^i).

We are particularly interested in efficient allocations of contracts and resources. We assume the resource owner is risk-neutral and therefore evaluates a collection of contracts according to the

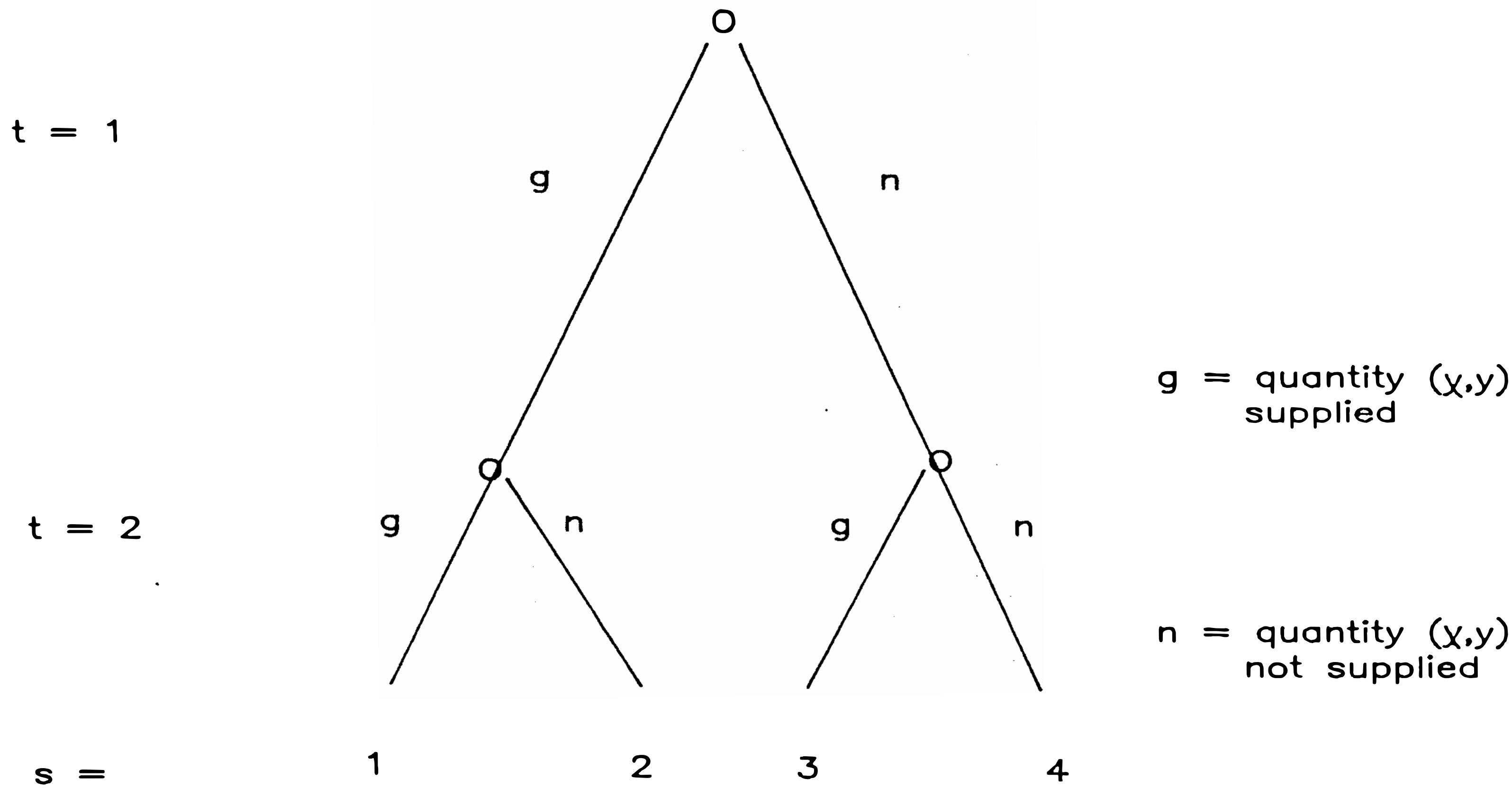


Figure 2 Structure of Supply

expected revenue generated,[13] which is simply $R(\Psi) = \Sigma_i b^i$. Thus, a collection of contracts Ψ is *efficient* if it is feasible and there is no other feasible collection Ψ' such that $R(\Psi') \geq R(\Psi)$ and $V^i(\Psi_i') \geq V^i(\Psi_i)$ for all i where one of these inequalities is strict. With priority contracts in this environment, a collection of contracts is efficient if and only if the associated resource allocation is Pareto-optimal. We can, therefore, restrict our attention to designing mechanisms to yield desirable allocations of contracts.

V. THE EXPERIMENTAL TESTBED

The next step in the design process is to create an experimental testbed consistent with the model of the environment. This testbed is to be a specific example of the environment that will supply a hard test for mechanisms.

The economic environment designed for the experiments follows the model in Section IV and involves two resources (X, Y) in fixed supply, two dates $(t = 1, t = 2)$ and two possible outcomes (g, n). The quantity of the goods for time period 1 are available (g) with probability ρ_1 and unavailable (n) with probability $(1 - \rho_1)$. Either the total quantity is available or no quantity is available for consumption. For time period 2 the probability of g is ρ_2 and of n is $(1 - \rho_2)$. ρ_2 is independent of the time period 1 outcomes. Table 1 shows the exact parameters used to represent the supply side of the experiments. There are two priority contracts associated with Figure 2 and Table 1 which we define as markets 1 and 2 respectively.[14] For these priority contracts the probability that at least one $X = 20$, $Y = 20$ capacity will be available is $\rho_1 + (1 - \rho_1)\rho_2 = 5/6$ and the probability that *both* $X = 20$, $Y = 20$ capacities will be available is $\rho_1\rho_2 = 1/3$.

The demand side was created using monetary functions to induce value (see Smith 1976). For subject $i = 1, \ldots, n$ values are induced by assigning each $(x_i, y_i) \in \Omega_i$ a monetary value of $M^i(x_i, y_i)$. If a subject has a von Neumann-Morgenstern utility function for money, $g^i(M^i)$, then for that subject $u^i(x_i, y_i, b_i) = g^i[M^i(x_i, y_i) - b_i]$. If the subject is risk-neutral, then $g^i(M^i) = M^i - b_i$. The (x_i, y_i) choices confronting the subjects are designed to be similar in spirit to those faced by a space station payload operator who must design an instrument and use some station resources to produce some output. (See footnote 11.) In the experiments only discrete amounts were made available for the (x, y) choices. In particular, each subject was given a 3×3 matrix of values corresponding to nine possible choices. There are two reasons for this. First, the experimental design was selected to make the fitting of demands a difficult task. If the mechanisms we are considering work well in this environment, they can easily be modified for operation in a more continuous demand structure. (See Banks, et. al, [1986] for a design with more continuous demand surfaces.) Second, the nature of the resource requests and design choices for Spacelab type instruments is best approximated by discrete demands. The actual valuation tables used in the experiments can be found in Appendix B. Subjects could only use the nine discrete choices available to them on the valuation sheets. We used six subjects per experiment and we reassigned the six valuation sheets to the participants after each market period in each experiment. (Subjects were told only that they would receive a new payoff sheet at the beginning of a market period.)

The specific parameters (payoffs and project sizes) chosen for the experiments required a computer search since the number of combinations that can fit within the available capacity limits

TABLE 1

Time period	Quantity of X	Y	Probability of Availibility
1	20	20	$\rho_1 = 2/3$
2	20	20	$\rho_2 = 1/2$

TABLE 2

	Configuration for first available $X = 20$, $Y = 20$, capacity				Configuration for next available $X = 20$, $Y = 20$, capacity			
	Sheet	X	Y	Value	Sheet	X	Y	Value
	1	12	9	\$3.25	4	8	12	\$2.75
	2	5	4	\$2.00	5	12	7	\$2.50
	3	3	6	\$1.25				
Total		20	19	\$6.50		20	19	\$5.25

Expected Value = (5/6)(\$6.50) + (1/3)(5.25) = \$7.17.

and provide action in the market is sizable given six 3×3 matrices of choices. The selection rule for the parameters in our design was quite subjective.

To develop a feel for the design, consider the configurations that maximize the expected value of the payoffs to the subjects using priority contracts in our tree structure which are listed in Table 2. Several observations are in order. First, the total capacity available (20×20) is not used up at the optimum because of the lumpy demand. Second, the priority 1 configurations required that the subjects with $x = 5, y = 4$ and with $x = 3, y = 6$ maintain an effective blocking "coalition" so that they cannot be replaced by configurations of participants not allocated resources in market 1. Furthermore, if we look at the valuation sheets found in Appendix B the individual with the $x = 5$, $y = 4$ configuration also has one with $x = 5, y = 9$ and a value of \$2.25 and the subject with the $x = 3$, $y = 6$ configuration also has one with $x = 3, y = 10$ and a value of \$1.50, so some tension remains in the coalition to deviate. Third, if the $x = 12, y = 9$ configuration were changed to $x = 12, y = 13$, there would be considerable action to contest or fit with this larger configuration by the remaining participants. Thus, even though the numbers used for the experiments are contrived they do provide a "hard" test for any mechanism designed to coordinate demands and priority to allocate resources efficiently.

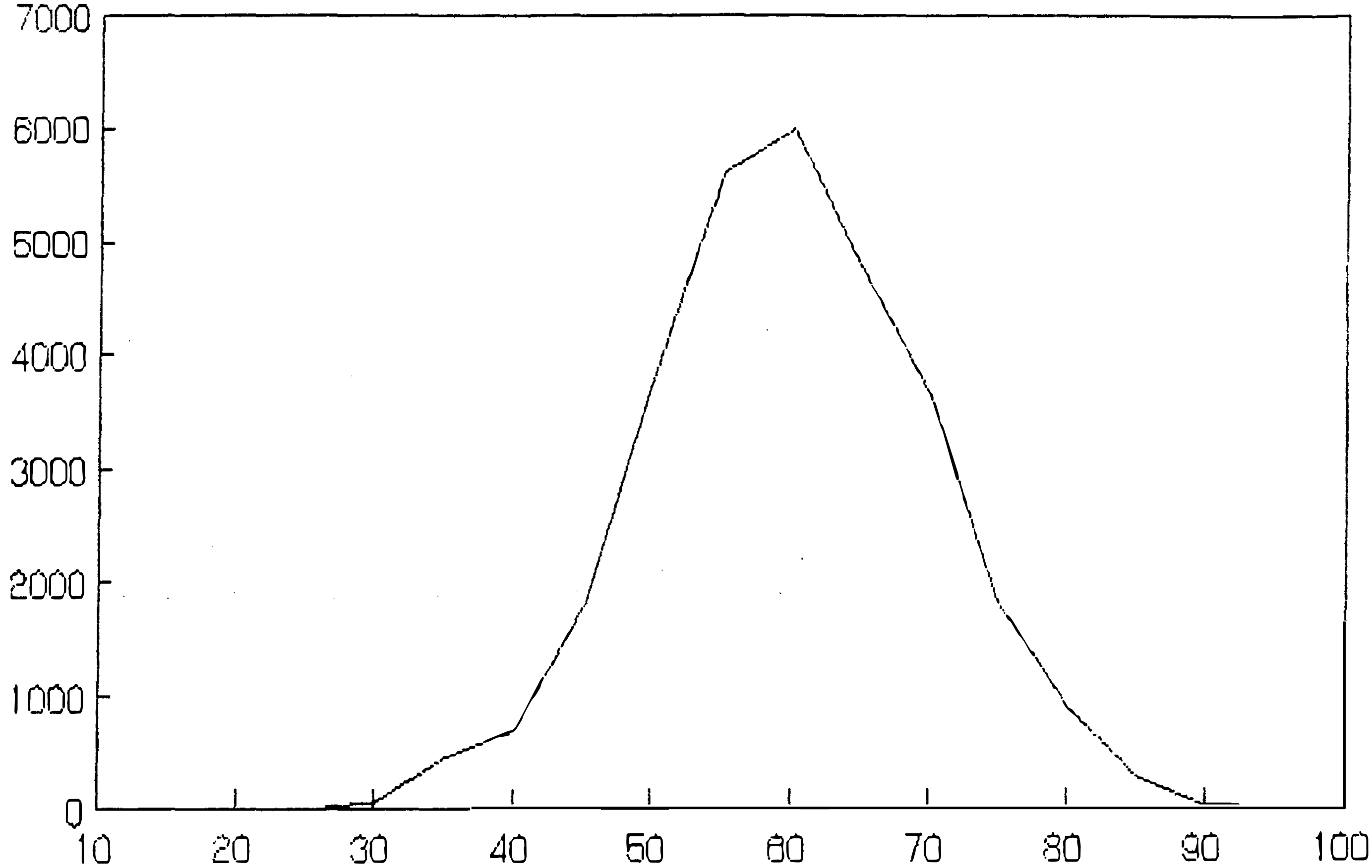
As another way to provide a feel for the design, we calculated the distribution of the expected value of user benefits (the expected payments M_i) of a random selection of 30,000 combinations of configurations which fit in the capacity constraints. The combinations were found as follows: first an individual valuation sheet i was selected at random (without replacement) and then one of its configurations (x_i, y_i) was selected at random and placed in the highest priority market. Next, another individual valuation sheet $j \neq i$ was randomly selected along with one of its configurations. This was placed in the allocation for the highest priority market such that $(x_i + x_j) \leq X$ and $(y_i + y_j) \leq Y$. This process continued until the set of available valuation sheets was exhausted. The expected value of $\Sigma_i M_i(x_i, y_i)$ was then calculated and the selection process started over again. If all subjects are risk-neutral then an efficient allocation of contracts (or resources) is one that maximizes the expected value of $\Sigma_i M_i(x_i, y_i)$. Therefore, the expected value of the payments for an allocation as a percent of the maximum of these expected values is a measure of the desirability of that allocation. We call this percent the (risk-neutral) *efficiency level.* We summarize the distribution of efficiency levels in Figure 3. Notice that the lowest possible efficiency level is in the 20-30% interval and that 85 percent of the distribution mass is between 75% and 40%. Hence, if we were to randomly allocate priority contracts we would expect efficiency levels in the range 40%-70%. We will later use the distribution in Figure 3 to define a posterior distribution to evaluate our test statistics to measure performance of our mechanism designs.

VI. THE BASELINE MECHANISM

One might judge new mechanisms by their ability to beat the random selection described in the previous section. However, we feel there is a strong reason for not doing so. Users are payload designers and operators and, as such, will not present all possible projects for selection. They can and may filter out "inefficient" designs in response to random selection. Therefore, the correct baseline against which to measure the performance of new mechanisms is the performance of a "random" mechanism in which users purposively select proposed projects d^i and then these are

Figure 3

Distribution of Efficiency
(30000 Random Combinations)



randomly selected and fitted. Rational agents may be able to improve on the unconstrained random selection of projects, unless the incentives of random selection (with a premium placed on "fitting") are so bad as to induce seriously inefficient project selection.

To create this baseline standard within the experimental testbed, subjects were told that there were two markets (corresponding to the outcomes $\{(g, n)$ and $(n, g)\}$ and $\{(g, g)\}$ in Figure 2) each with capacity $X = 20$, $Y = 20$. Subjects could submit only one order consisting of an x and y configuration and a preference for ranking over markets 1 and 2. The orders were collected and randomly selected one at a time from a box and placed in the first market with capacity available in accordance with the stated preference rankings. When all the capacity or orders were exhausted a die was rolled. The orders in market 1 were filled if any of the numbers 1 through 5 appeared and the orders in market 2 were filled if the number 1 or 2 appeared.[15] These probabilities were known by all participants prior to placing their orders. If a participant's order were filled she received the value associated with the configuration ordered. Since prices were not used to allocate resources, subjects needed to pay nothing.[16] We call this baseline mechanism the *Random Mechanism.* Aside from its use as a performance standard, it is a reasonable representation of STS pricing and allocation policy prior to the "Challenger disaster." That policy, summarized in Section III, consisted of a posted price (which was zero for NASA sponsored payloads) and an allocation policy based on exogenous priority assignment and a first-come, first-served (which is essentially random) selection of available payloads.

Three predictions about the behavior of users participating in the Random Mechanism can be derived from an analysis of their strategic situation. Once each participant has chosen a resource order and a preferred market $<d^i, f^i>$, the mechanism selects and assigns at random. This selection process implies a probability that i will receive d^i in market 1 or 2. Let $H_f^i(<d^1, f^1>, \ldots, <d^n, f^n>)$ be that probability. H_f^i is the probability that d^i will still be available in f when i's order is drawn. H_f^i does not depend on f^i but does depend on f^j for $j \neq i$. If ρ_f is the probability that contracted amounts with priority f are delivered then i's expected value of an order $<d^i, f^i>$, *given the orders of others*, is

$$H_f^i(d^i)\rho_f u^i(d^i, 0) + [1 - H_f^i(d^i)]H_r^i(d^i)\rho_r u^i(d^i, 0)$$

where $f = f^i$ and r is the other market. (That is, if $f = 1$ then $r = 2$ and vice versa.) Thus, i's expected value, given the orders of others, is

$$[H_f^i(d^i)\rho_f + [1 - H_f^i(d^i)]H_r^i(d^i)\rho_r]u^i(d^i, 0) \equiv \theta^i(d, f)u^i(d, 0).$$

One prediction is immediate: to maximize expected value, $f^i = 1$ if and only if $\rho_1 > \rho_2$; that is, i will always rank higher the contract with the higher probability of delivery. (This is a dominant strategy, independent of the others' choices.) The second prediction is almost as direct and can be summarized as: individuals will choose project sizes smaller than their projects with the highest payoff (so they may fit).[17] The third observation is that projects chosen under the random mechanism will "regress to the middle." That is, compared to the allocation which maximizes expected aggregate benefits (see Table 2), the participant will choose larger than that if the allocation is small (like 2 in Table 2) and smaller than that if the allocation is large (like 1 in Table 2).

Therefore, not only might this mechanism pick projects with benefits less than those it excludes, but also almost all projects that are selected will be inefficiently sized.[18] The issue is whether any other mechanism can do better.

VII. THE DESIGNS

The next step in the mechanism design process is to create generic designs which seem appropriate for the problem and then to test it.

A. Design #1 - Description

The first design we report is a generalization of the English (or ascending-bid) auction (see Cox, Roberson and Smith [1980] for a description and analysis of a traditional English auction). We call it the *Adaptive User Selection Mechanism (AUSM)-Bulletin Board.*

AUSM does not require all participants to be in the same room (as in Sotheby's art auction); they can communicate "bids" through an electronic bulletin board. Nor does it require a rapid sequence of bids to be made (as in the art auction); participants can be allowed any length of time thought to be desirable to consider their demands. AUSM is not a spot market and requires no auctioneer.

The English auction, upon which AUSM is based, is a non-tatonnemont process that is commonly and widely used to auction single items of uncertain value to multiple bidders. At each instant during the auction there is a potential allocation across contracts, which is common knowledge. Any agent can enter a bid at any time. The bid is common knowledge. There is a common update rule which specifies how a new bid can create a new potential allocation. The process stops when no new bid is made soon enough after the last bid. The potential allocation is then the actual allocation.

For auctions of single items the potential allocation is usually expressed as "the item goes to the current highest bidder who will pay their bid," and a bid is "a stated willingness to pay." The update rule is that the person bidding becomes "the current highest bidder at that bid" if their bid is higher than that of the current highest bidder. If not, no change occurs.

For multiple contracts of multiple dimensions, the principle is exactly the same. There is a supply of each of F contracts to be allocated. The capacity of each is $\bar{y} \in \mathbf{R}^k_+$. [We can easily modify this to accommodate an environment in which y depends on $f \in F$]. For our environment, $F = \{1,2\}$, and $\bar{y} \in \mathbf{R}^2_+$.

A potential allocation is a feasible collection of contracts ψ. A bid is simply a proposed contract (f, d^i, b^i). A bid replaces a contract (or group of contracts) in the potential allocation ψ if and only if the b^i is higher than the sum of the bids offered by those being replaced. More formally, let K_f be the agents who hold contracts in the current potential allocation of f and let $R \subseteq K_f$. If $Z_f + \sum_{j \in R} d^j \geq d^i$ and $b^i \geq \sum_{j \in R} b^j$ where $Z_f = \bar{y} - \sum_{w \in K_f} d^w$, then (f, d^i, b^i) replaces the collection $\{(f, c^j, b^j)\}_{j \in R}$ in ψ. If there is no such R then the new allocation equals the old (i.e., i's bid is rejected). If there are more than one such R, we assume that i replaces the R with the smallest value of $\Sigma_{j \in R} b^j$. Trader i's utility for the potential allocation of contracts ψ is $V^i(\psi_i)$ if $i \in K_f$ for $f = 1$ or 2 and is 0 otherwise.

The potential allocation can be publicly displayed on a (computerized) Bulletin Board as, for example, in Table 3. For this example, if bidder 2 wanted to be manifested on the contract "priority 1" for an amount of $(x,y) = (10,3)$, 2 could do so by bidding (10, 3, 0). If 2, on the other hand, wanted $(x,y) = (12,6)$, 2 would have to bid at least 201 (to bump 3). If 2 wanted $(x,y) = (12,11)$, 2 must bid at least 501 (to bump 7) and if 2 wants (6,16), 2 must bid 701 (to bump both 3 and 7).

We chose this basic mechanism for several reasons: (1) the practical success of the single unit English auction as signaled by its widespread use, (2) the feeling, based on experimental experience, that in an environment in which the bases for common knowledge are little understood or controlled, iterations allow subjects to "feel their way" in a manner in which sealed-bid, one-shot auctions do not,[19]and (3) a theoretical analysis of its properties. Let us briefly expand on the last.

We emphasize two facts about the AUSM-Bulletin Board. First, given a proposed allocation any i can, with a high enough bid, change the proposed allocation to one in which i's contract f is for any amount less than or equal to y. Second, the proposed allocation puts a lower bound on how much i must bid in order to achieve any desired allocation on contract f. Let $\xi^i(\psi^*)$ represent the set of contract allocations to which i can unilaterally cause ψ^* to be changed with some bid. We call ψ^* a *simple equilibrium* if ψ^* is feasible and if $\forall i = 1, \ldots, n$; $\xi^i(\psi^*) \cap \{\psi \mid V^i(\psi) > V^i(\psi^*)\} = \varnothing$. That is, no i can unilaterally improve his position since any bid high enough to cause i's quantity d^i to be included in the allocation of contract f will be higher than the value of the benefits attained from those d^i units of contract f. Simple equilibria are contract allocations which are individually "stationary" allocations of AUSM. This is a fairly big set, not all of which are desirable. Further, we feel that reasonably well informed traders will be able to avoid some of them. To see how, consider a slightly different mechanism.

Suppose each i chooses a contract $m_i = (f, d^i, b^i)$. Given $m = (m_1, \ldots, m_n)$, a potential allocation of contracts $\psi^*(m)$ is chosen as follows: for each f pick K_f to max $\sum_{i \in K_f} b^i$ subject to $\sum_{i \in K_f} d^i \leq \bar{y}$. Then allocate to i the contract f in the amount of d^i, b^i if $i \in K_f$. One can think of this as a game, G, with strategies m^i and outcome function $\psi^*(m)$, with allocations picked to maximize the aggregate *stated* willingness to pay. It could be used as a "sealed bid" mechanism. We call ψ^* is a *non-cooperative equilibrium allocation* of G, if $\psi^* = \psi^*(m^*)$ and for each i, $V^i(\psi^*) \geq V^i(\psi^*(m^*/m^i))\ \forall\, m^i$, where (m^*/m^i) is the vector m^* with m_i^* replaced by m^i. It is an obvious fact that if ψ^* is a non-cooperative equilibrium allocation of G, then ψ^* is a simple equilibrium of AUSM. The converse is not necessarily true.

Based on previous experimental experience with games such as G, it is not unreasonable to expect in experimental testing with replications of the AUSM-Bulletin Board that the final allocations will be non-cooperative equilibrium allocations of G. *Not* all simple equilibria will occur in replicated situations when subjects can learn to avoid "bad" dynamics. Of course what the mechanism designer is really interested in is not the equilibria but the efficiency of the equilibrium allocations. Unfortunately, even if only non-cooperative equilibria occur, the associated allocations may not be desirable.

Because of the lumpy nature of the users projects, there are non-cooperative equilibrium allocations of G which are not efficient contract allocations. There may be changes in those allocations involving several traders *simultaneously* which can make all better off. In particular, if,

TABLE 3

Priority 1				Priority 2			
Bidder	x	y	bid	Bidder	x	y	bid
7	2	10	500	1	15	2	50
3	6	5	200	4	1	10	75
				5	4	8	100
Supply	20	20		Supply	20	20	
Slack	12	5		Slack	0	0	

during the auction, there is a large user who is part of the current potential allocation and who has a fairly high bid, it may be too costly for any one small user to displace him even if it is possible that several small users can together receive more benefits than the single large user and should replace him. In this situation unilateral actions by one user are not sufficient to drive the mechanism to a more efficient allocation of contracts.[20]

In our initial testing of the AUSM-Bulletin Board, we had hoped that these complications caused by the variable size demands would be overcome by the subjects. But early data (reported in detail below) suggested efficiency levels of only 75-85%. We therefore felt it important to try to overcome this limitation of the mechanism. To do so, we had to improve the ability of the mechanism to recognize when to replace one big user with two or more little users. Our solution was not only to allow small users to coordinate their bids but to encourage them to do so. We created a new mechanism by modifying AUSM in the following ways. A public "standby" queue was allowed in which any agent could post a "proposed bid" (f, d^i, b^i) which they (presumably) would be willing to have included in a coalitional bid. Because of the possibility of joint bids from a group γ of individual agents, we expected different equilibria with the queue than we had hypothesized would arise in AUSM without the queue.

Let $\gamma \subseteq \{1, \ldots, n\}$ be an arbitrary coalition of agents and let (m^* / m^γ) be the vector m^* with m_i^* replaced by m_i for all $i \in \gamma$. We call ψ^* a *strong non-cooperative equilibrium* of G if $\psi^* = \psi^*(m^*)$ and for each coalition γ and each $m^\gamma \neq m^{*\gamma}$ there is at least one $i \in \gamma$ such that $V^i(\psi^*(m^*)) > v^i[\psi^*(m^*/m^\gamma)]$. If ψ^* is a strong non-cooperative equilibrium of G, then ψ^* is a non-cooperative equilibrium of G. The converse is not necessarily true.

Our hope was that offering the subjects the opportunity to "publicly" coordinate their bids through the queue would lead them to strong non-cooperative equilibria of the game G (if such equilibria existed). If that occurred, then this variation in the AUSM rules would solve our problem since those equilibrium allocations of G are efficient.

The queue was the only major design change we made in response to early testing. There were, however, two other minor, but significant, variations in design which we chose in response to experimental testing. Originally, we had a stopping rule (which specifies when the provisional manifest is to be accepted as final) which had some undesirable effects. The auction would run for T minutes and the allocation at T would be final. Under this rule, very little bidding occurred in the pilot experiments until $T - \varepsilon$ when a flurry of bids were presented. Allocations were almost random. This was easily solved by changing the rule to the more traditional one in which the auction ends if no new bids occur after S seconds, where S is a design choice. The other variation concerned the commitment entailed in placing an order in a market. In one pilot, we used the same ordering process as above, except that subjects could remove existing orders and change bids up or down while in a market. There was no queue, but combining to move to different markets was allowed. This had an effect similar to the first stopping rule. Without commitment, nothing serious happened until $T - \varepsilon$. We fixed this by revising the rules, by which bidding could be done, in a way which made each bid a potentially binding contract. Further, an explicit improvement rule, for bids, was added. Finally, in our initial design of the standby queue we allowed participants with orders in the standby queue to veto proposals combining with their order. We abandoned this rule in favor of committed bids in the queue when we found no vetos.

B. Design #1 - As Tested

When the market opened subjects would submit an order consisting of a market or the standby queue, an x and y choice and a bid by raising their hand and being identified. Their order would be accepted if it could fit within the available capacity of the market requested, if it could displace existing orders with lower bids, or if the standby queue was requested. If a subject wanted to use the standby queue he had to indicate for which market the bid was tendered. Furthermore, if a subject's bid in the standby queue were combined with another order, then any standing order the subject had in a market was canceled. Finally, to aid in the search process for the best configurations, subjects were allowed to move existing configurations to other markets and/or change their configuration and bid if it could fit in the available capacity. However, if a subject did change his configuration in a market he had to improve the bid of the total orders he was displacing *including* (if necessary) his original order. For example, suppose the orders in market 1 were as follows:

Market 1

Subject	X	Y	Bid
2	12	9	150
4	5	4	100
5	3	6	75

If subject 2 wanted to change his configuration to $x = 12$, $y = 13$ he would have to bid more than 225. The bid improvement increment was set at 5. If an order was displaced the subject was allowed to reorder through the process above and submit any feasible order he or she wanted. The auction stopped when there were no new orders or order changes within 30 seconds of the last order. When the market closed a die was rolled. If the number 1 through 5 appeared the orders in market 1 were filled. If the numbers 1 or 2 appeared the orders in market 2 were filled. If an order was filled the subject was given his redemption value minus his bid. If a subject's order was not filled his bid was subtracted from his accumulated earnings. If a subject did not have an order in a market the subject received zero earnings for the market period. At the beginning of the experiment each subject was given 7 dollars of working capital to add to his earnings since losses in any market period were possible.[21]

The AUSM mechanism without a queue was also tested. The instructions for both AUSM mechanisms can be found in Appendix C.

C. Design #2 - Description

The second design we report is based on a Vickrey-Groves type of sealed bid auction (Vickrey [1961]), where the prices charged to a user for resources are a function only of what the *other* participants bid. This then creates the correct incentives for the participants to truthfully reveal their willingness to pay for all possible contracts. Vickrey-Groves mechanisms, however, require each bidder to report an entire demand function, thus rendering the informational tractability of such a mechanism problematic in an environment with multiple units and multiple dimensions.

Therefore, we modify this auction by constructing a mechanism with iterations wherein each participant selects only one resource demand per trial of the process, and where prices at each trial are consistent with the logic of the Vickrey-Groves auction. It is thought that, with sufficient iterations, information will be generated through the prices which will accurately reflect the "cost" of all possible contracts.

The process proceeds in time periods $1, \ldots, \alpha, \ldots$ prior to any realizations of supply. At time α, each $i \in N$ privately submits a contract $(f(\alpha), d^i(\alpha), b^i(\alpha))$. For each f, define $N_f(\alpha)$ as those users submitting a request for a contract of type f. Let

$$\Gamma(f,\alpha) = \{\gamma \in \Omega(N_f(\alpha) : \sum_{j \in y} d^j(\alpha) \le \bar{y}\}.$$

$$K_f(\alpha) = \underset{\gamma \in \Gamma(f,\alpha)}{argmax} \sum_{j \in \gamma} b^{\text{if}}(\alpha),$$

$$\gamma_i(f,\alpha) = \underset{\substack{\gamma \in \Gamma(f,\alpha) \\ i \notin \gamma}}{argmax} \sum_{j \in \gamma} b^{\text{if}}(\alpha) \;\; st. \;\; \sum_j d^j(\alpha) + d^i(\alpha) \le \bar{y},$$

$$\beta^i(f,\alpha) = \max_{\substack{\gamma \in \Gamma(f,\alpha) \\ i \in \gamma}} \sum_{j \in \gamma} b^{\text{if}}(\alpha) - \sum_{r \in \gamma_i(f,\alpha)} b^{rf}(\alpha).$$

For a contract of type f, $\Gamma(f, \alpha)$ identifies all feasible coalitions; i.e., all groups of users whose collective bids are feasible, while $K_f(\alpha)$ selects the coalition with the maximum sum of bids. If $i \in K_f(\alpha)$, then $\gamma_i(f, \alpha)$ is simply $K_f(\alpha) - \{i\}$, while if $i \notin K_f(\alpha)$ then $\gamma_i(f, \alpha)$ identifies the coalition in $\Gamma(f, \alpha)$ which 1) would remain feasible if i were added, and 2) maximizes the sum of bids of its members. Thus, joining with $\gamma_i(f, \alpha)$ is i's "best chance" of acquiring a contract of type f, given the behavior of the other participants. Given a vector $d(\alpha)$ of resource demands, the "price" $\beta_i(f, \alpha)$ that trader i faces for contract f is equal to either the social cost of i being in $K_f(\alpha)$ in terms of revenue foregone by i's inclusion, or the minimum amount b^i needed to become a member of $K_f(\alpha)$, holding other traders' bids constant. In the former, the first term on the *RHS* of the price equation is the amount generated if i did not participate; thus, subtracting off the bids by other members of $K_f(\alpha)$ gives an equivalent version of the Vickrey-Groves "second price" auction of a single unit of a good. Thus, given $d(\alpha)$ and assuming risk neutrality, bidding one's expected value for a contract is a dominant strategy. In the latter, the first term is simply the sum of bids of the members of $K_f(\alpha)$; thus, subtracting off the bids of i's "best chance" coalition gives the amount i would have had to have bid.

Before proceeding to $\alpha + 1$ each i observes $\{\beta^i(f, \alpha)\}_{f \in f}$, as well as $d(\alpha)$. Thus, at each trial, the participants gain information concerning not only the demand for resources and contracts that they (provisionally) acquire, but also for those which they do not. In this way, as the iterations proceed and bidders search for their "best" alternative, the mechanism may lead to an efficient outcome, if participants adopt their "short-run" dominant strategy of bidding their true value.

The process stops at α if $K_f(\alpha - 1) = K_f(\alpha)$, $\forall f \in f$. That is, the process only stops when some sort of stability has been reached wherein the set of participants acquiring resources for each contract type remains unchanged.

D. Design #2 - As Tested

The determination of allocations and the calculation of individual prices for this mechanism is an enormous task which cannot be done by hand in an effective manner. Thus, for testing this mechanism, all communication and calculations were made using a network of personal computers (PCs). The PCs were connected on a local area network with a controller PC being the center where messages were received, prices were calculated and allocations were determined, and then this information was transmitted back to subjects.

At the beginning of a trial in a market period an individual would submit a configuration (x, y) and select either market 1 or market 2 (but not both markets). The subject would then enter a bid for the configuration. After each individual sent his message to the center it calculated the provisional allocation and prices for each participant. Each individual user was then informed of the provisional traders in each contract and their configurations based on the trial messages. In addition, each subject received a private price message which described their potential payment if they were part of the provisional allocation, or (if they were not) the amount they would have had to bid in order to have their configuration included in the provisional allocation. The algorithm used to calculate allocations and prices and to return this information to subjects took less than one second to transmit after the last message was entered. Furthermore, each subject had displayed on their screen the history of the last three trials including provisional allocations and prices. Appendix B supplies the subject screen display for this mechanism.

The stopping rule for allocating the contracts was partially sequential. In particular, the process stopped if the same subjects and configurations occurred in the markets (contracts) three times in a row (rule A). Otherwise, market 1 closed after t_1 trials were exhausted; market 2 closed after t_2 trials if rule A were not executed, where $t_2 > t_1$.

The only restrictions on the individuals messages were that $b^i > 0$ (and integer valued) for each trial, the (x, y) must be one of i's nine choices, and a subject could submit a bid for market 1 or market 2, but not both markets, in the same trial. There was no ratchet (improvement) rule for individual bids in the process and a bid was not necessarily binding because one can bid "very high" in trial t and then bid almost zero in trial $t + 1$. We chose this set of rules to allow individuals to "easily" search for combinations. The instructions for this experiment can be found in Appendix C.

The rules above were developed in response to early testing. Initially we did not close the markets sequentially. However, the process was pushed by the subjects to the last trial in most instances (even with 40 trials) and since an individual could only bid for market 1 or 2 (not both) there was substantial excess supply at the close. We also instituted a rule in the early testing which required individuals to better *their* previous bids in the market they were ordering. This rule caused individuals to be cautious in their bidding or "locked" them into larger projects and so was eliminated.

VIII. EXPERIMENTAL RESULTS

A. Measurement

We measure three aspects of mechanism performance: efficiency, revenue, and individual behavior. The overall performance of the mechanisms is determined by using expected values of efficiency. This does not necessarily measure the *ex ante* efficiency of mechanisms since it does not account for the risk preferences of the subjects;[22] nevertheless, it does measure the *ex ante* system performance from the point of view of a risk neutral planner. We also consider the extent to which revenue is generated by each mechanism. Finally, we evaluate individual behavior for how well it corresponds to theoretical Nash equilibrium behavior.

Table 4 contains the relevant information for each experimental session. Recall, for each session, we randomized the redemption value sheets at the beginning of a market period.

B. Overall Mechanism Performance

The mean efficiency (percent of the maximum expected value (μ)) and the associated standard deviation (σ) and coefficient of variation (ν) for each mechanism can be found in Table 5. We see that both AUSM and Iterative Groves mechanisms generate efficiencies near the 80% level, while the Random mechanism produces efficiencies close to 65%. Figure 4 provides the histograms of efficiency for each of the mechanisms. While this difference may not seem substantial, recall that the distribution of combinations in Figure 3 shows that there are relatively few choices that can produce efficiencies above 75%. If we were to use this as our posterior distribution, we would place a higher weight on observations with higher efficiencies. The nature of the underlying distribution of combinations found in Figure 3 suggests the use of nonparametric methods for our statistical analysis. We will use the Wilcoxon Rank Sum to test the equality of distributions of efficiency generated by each mechanism. In particular the z scores to be reported are derived from testing the hypothesis of equality of distributions versus strict inequality of distributions. Table 6 provides the Wilcoxon Rank Sum Test for each mechanism using the data from all periods. That is, we have pooled the data from each experiment. While this affords more degrees of freedom we may be biasing results if substantial learning occurs in a mechanism. We shall check for these biases a bit later.

The distribution free prediction intervals of efficiency for each mechanism with lower bound .90 for their coverage probability are:

[74.8, 86.8]	-	AQ
[71.5, 83.9]	-	A
[67.7, 88.1]	-	IG
[43.5, 83.5]	-	RP

Our statistical measures in Table 6 support the following ranking of the mechanisms by efficiency as follows:

TABLE 4
Summary of Experiments

Experiment	Mechanism	Contract	Subject Pool	Number of Periods
1*	Random	Priority	Caltech	2
2*	Random	Priority	Caltech	3
3	AUSM	Contingent	Caltech	5
4	Random	Contingent	Caltech	2
5	AUSM	Contingent	Caltech	4
6	Random	Contingent	Caltech	3
7*	Random	Priority	Caltech	2
8	AUSM	Priority	Caltech	5
9	AUSM with Queue	Priority	Caltech	5
10	AUSM with Queue	Priority	Caltech	5
11	AUSM	Priority	Caltech	5
12	Random	Priority	PCC	5
13	Random	Priority	Caltech	5
14	AUSM	Priority	Caltech	5
15	AUSM with Queue	Priority	Caltech	5
16	AUSM	Priority	PCC	5
17	AUSM with Queue	Priority	Caltech	5
18	Iterative Groves	Priority	Caltech	5
19	Iterative Groves	Priority	Caltech	5
20	Iterative Groves	Priority	Caltech	5
21	Iterative Groves	Priority	Caltech	5

*These experiments were conducted in conjunction with pilot experiments testing various forms of the AUSM process.

Caltech = California Institute of Technology
PCC = Pasadena City College

TABLE 5
Efficiency by Mechanism (Priority Contracts)

Mechanism	μ	σ	v	Range
Random (*R*)	63.5	10.0	.16	[39, 76]
Iterative Groves (*IG*)	77.9	6.8	.09	[60, 91]
AUSM (*A*)	77.7	4.1	.05	[71, 86]
AUSM with Queue (*AQ*)	80.8	4.0	.05	[72, 86]

TABLE 6*
Rank Sum Test (All Periods)

	IG	A	AQ
R	$z = 4.39$ $\alpha = .000$	$z = 4.36$ $\alpha = .000$	$z = 4.72$ $\alpha = .000$
IG		$z = -.004$ $\alpha = .480$	$z = 1.58$ $\alpha = .057$
A			$z = 2.12$ $\alpha = .017$

* α indicates the level of significance for the test that the efficiency of the mechanism in the column equals that in the corresponding row.

Figure 4

Histogram of Efficiency

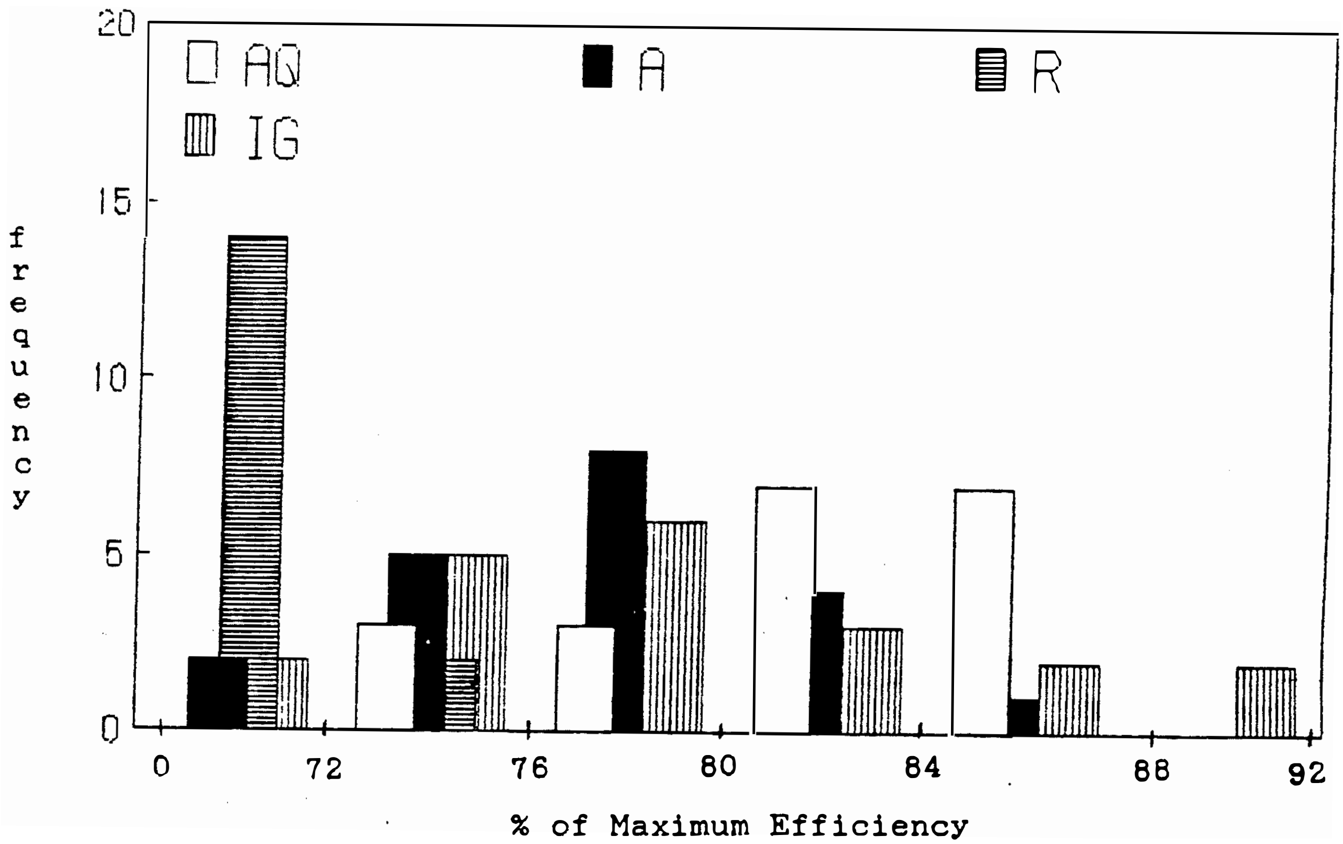
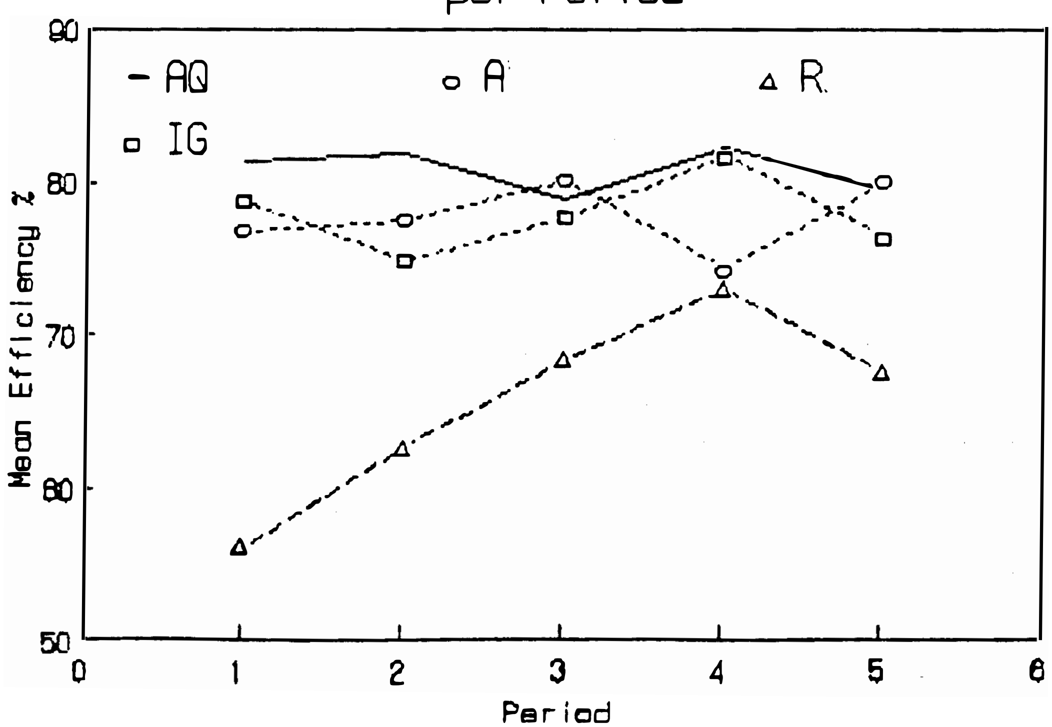


Figure 5

Mean Efficiency by Mechanism per Period



$$\boxed{\begin{array}{c} R < A = IG < AQ \\ \text{with} \\ (AQ - IG) \leq (AQ - A) < (A - R). \end{array}}$$

C. Efficiency by Period

The mean efficiency per period for each mechanism can be found in Figure 5. We notice that for the Random mechanism the level of efficiency tends to increase over time. In particular, the mean and standard deviation of efficiency for periods 3 and above is 69.4 and 5.4 respectively. Thus, we see that efficiency increases with repetition in the Random mechanism (the reduction in the standard deviation in the later periods suggests that these higher efficiencies will be maintained. See Figure 15-20 in Appendix D for the time series data). A preliminary explanation of this trend is based on individual choices which select larger projects in early periods and smaller projects in later periods so as to fit. As an indication of this fact, Figures 6 and 7 provide the excess capacity per dimension by period for each mechanism.

For AUSM with and without a queue and Iterative Groves, there is no significant effect of repetition. The mean efficiency for periods 1 and 2 was 77.1 for A, 81.6 for AQ, and 76.8 for IG, while the mean efficiency for periods 3 and above was 78.1 for AP, 80.2 for AQ, and 78.6 for IG. (See Appendix D for the time series of efficiency.)[23]

In summary, we see that AUSM and Iterative Groves mechanisms clearly outperform the Random mechanism in terms of our measure of efficiency. The gap in efficiency is reduced but not eliminated when the Random process is repeated with the same subjects. The addition of the queue in AUSM improves efficiency, but only slightly.

D. Revenue Generation

In Section VIIA we saw that, on theoretical grounds, AUSM with a queue should be more efficient than without a queue in allocating resources. Does this mean more revenue is generated from the process, or does the ability to form "coalitions" via the standby queue reduce the revenue? Tables 7 and 8 provide the mean revenue (total and by market) for each treatment, and the associated standard deviation and coefficient of variation. Figure 8 provides the histogram of the overall revenue generated from the processes.

From Table 7 we see that the addition of the standby queue results in a higher mean revenue and a shift in the support to the right. If we look at the revenue generated by market we see that with a queue, the volatility of revenue is fairly low for market 1 and high for market 2. Without a queue, revenue from each priority contract is relatively volatile. Of course, priority 1 contracts received higher bids. Specifically, priority 2 contracts have a mean bid 1/3 that of priority 1 contracts (approximately the difference in probability of each market being filled). Table 9 supplies the rank sum and *t* tests for the overall revenue generated by each of the AUSM and IG treatments, while Table 10 provides these same tests for each of the markets.

We see that the existence of the standby queue results in significantly higher revenues and this comes from higher revenue generated in both markets 1 and 2. If we look at the time series of the overall revenue per mechanism in Figures 21-33 in Appendix D we notice a slight upward trend

Figure 6
Mean Excess Capacity per Period
for Market 1

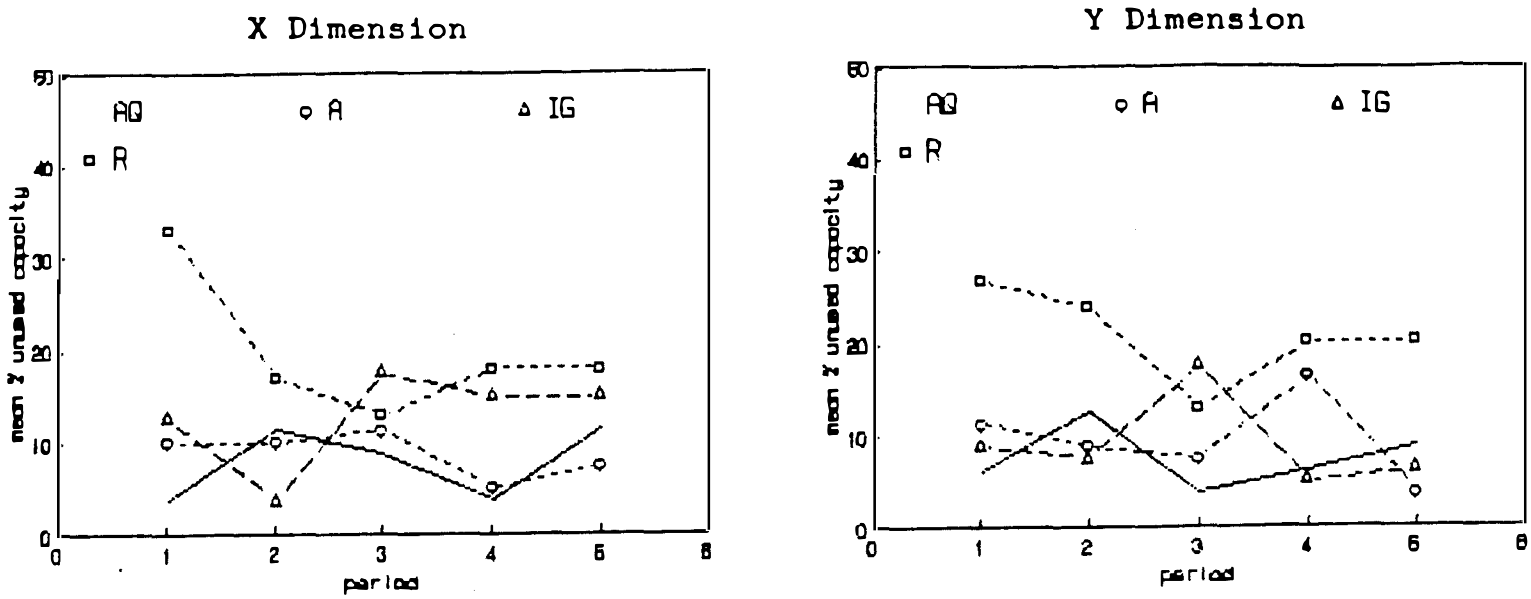


Figure 7
Mean Excess Capacity per Period
for Market 2

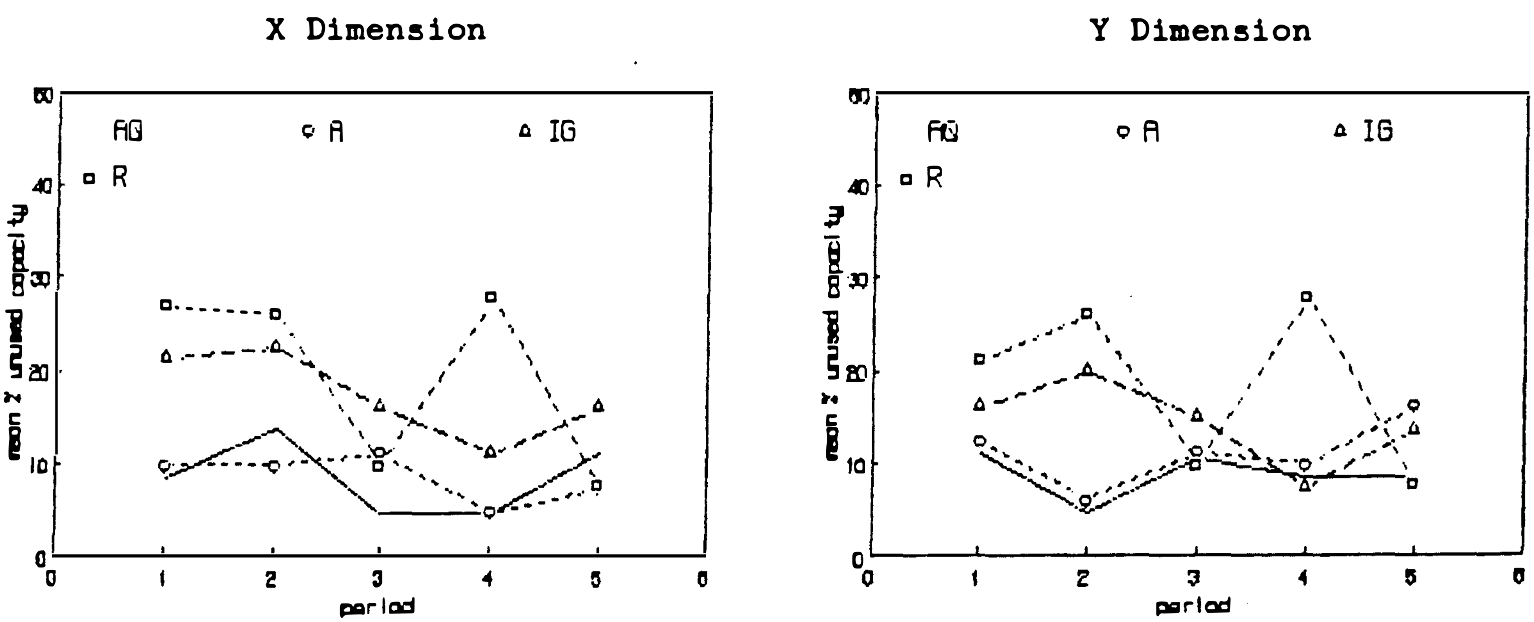


Figure 8

Histogram of Revenue

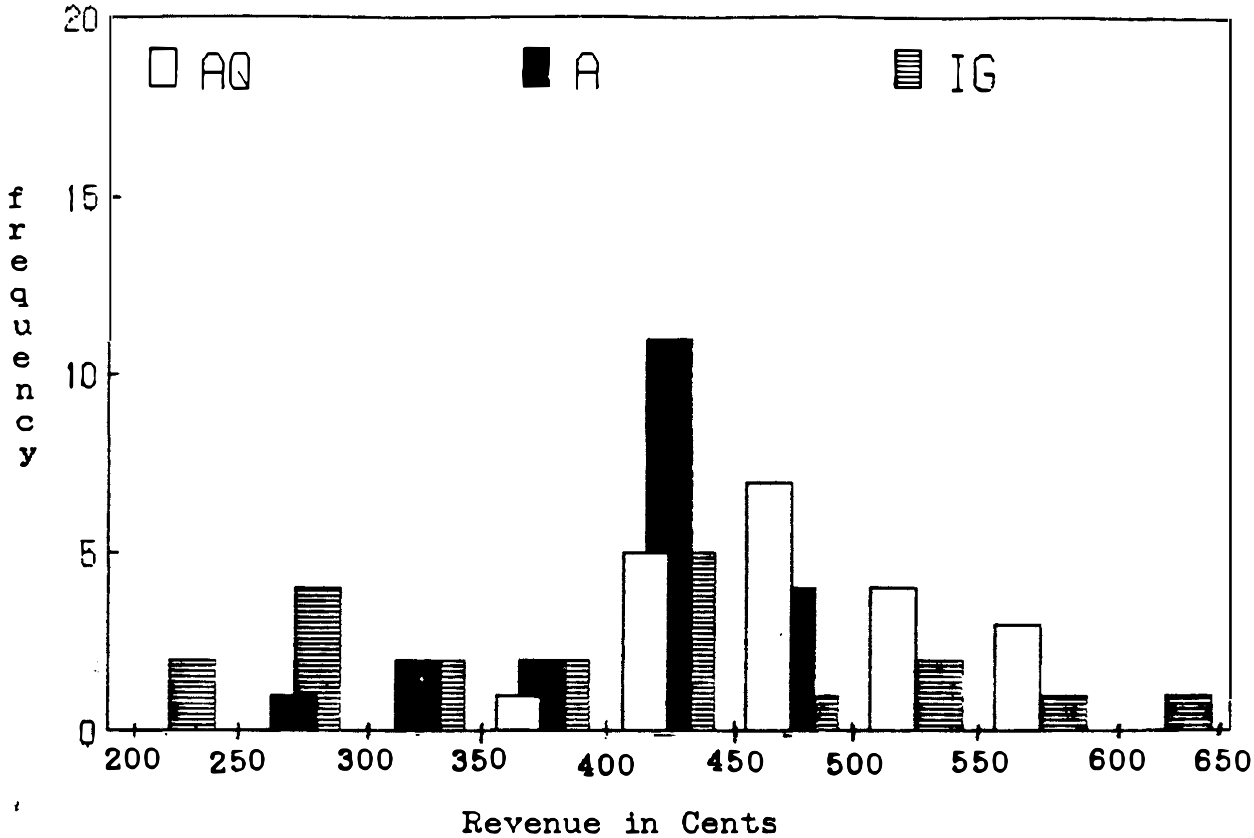


Figure 9

Queue Use vs Revenue Generated

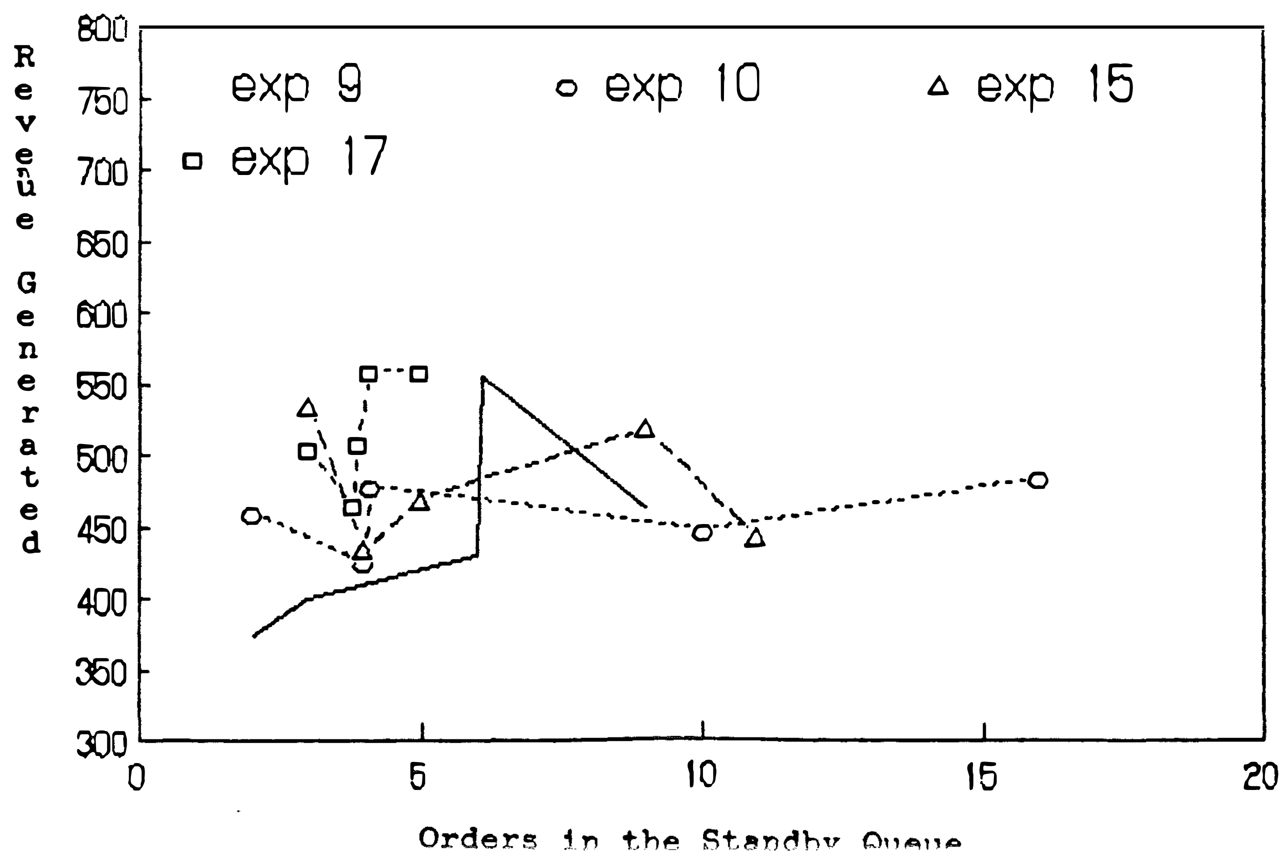


TABLE 7
Total Revenue Generated

Treatment	μ	σ	ν	Range
A	404.5	48.7	.12	[284, 475]
AQ	475.7	52.0	.11	[375, 560]
IG	388.4	118.2	.30	[210, 656]

TABLE 8
Revenue by Market

Treatment	Market 1				Market 2			
	μ	σ	ν	Range	μ	σ	ν	Range
A	302.2	52.9	.18	[154, 365]	102.3	22.6	.22	[70, 145]
AQ	353.7	36.2	.10	[300, 425]	122.0	27.5	.23	[75, 185]
IG	284.1	85.1	.29	[160, 449]	108.1	66.3	.61	[00, 240]

TABLE 9*
Rank Sum and t-Test for Overall Revenue Generated

	AQ		*IG*	
A	$z = 3.69$ $\alpha = .00$	$t = 3.59$ $\alpha = .07$	$z = -.65$ $\alpha = .25$	$t = -.55$ $\alpha = .29$
AQ			$z = -2.85$ $\alpha = .00$	$t = -2.95$ $\alpha = .00$

*α indicates the level of significance for the test that the revenue generated by the mechanism in the column equals that in the corresponding row.

TABLE 10*
Rank Sum and t-Test in Priority Markets

	Market 1 (*AQ*)		Market 2 (*AQ*)	
A	$z = 2.25$ $\alpha = .01$	$t = 2.48$ $\alpha = .01$	$z = 3.69$ $\alpha = .00$	$t = 4.45$ $\alpha = .00$

*α indicates the level of significance for the test that the revenue generated by the mechanism in the column equals that in the corresponding row.

TABLE 11
Mean Revenue

	Periods 1 and 2	Periods 3+
A	374	425
AQ	470	480
IG	351	413

TABLE 12*
t-Tests for Mean Revenue - Early vs Later Periods

	A 3+	*AQ* 3+	*IG* 1 and 2	*IG* 3+
A 1 and 2	$t = 2.65$ $\alpha = .01$	$t = 4.44$ $\alpha = .00$	$t = -.53$ $\alpha = .30$	$t = .93$ $\alpha = .18$
A 3+		$t = -2.68$ $\alpha = .00$	$t = -2.13$ $\alpha = .03$	$t = -.16$ $\alpha = .43$
AQ 1 and 2	$t = -2.29$ $\alpha = .01$	$t = .35$ $\alpha = .36$	$t = -2.80$ $\alpha = .01$	$t = -1.07$ $\alpha = .15$
AQ 3+	$t = 2.68$ $\alpha = .00$		$t = -3.65$ $\alpha = .00$	$t = -1.53$ $\alpha = .07$
IG 1 and 2				$t = 1.16$ $\alpha = .13$

*α indicates the level of significance (one-sided) for the test that the revenue generated by the mechanism in the column equals that in the corresponding row.

in the revenue in AUSM which is traceable to the revenue generated in market 1. No such trend is found by examining the time series for AUSM with a queue. We also notice that the revenue generated by IG is quite volatile. Table 11 supplies the mean for periods 1 and 2 and periods 3+ for each mechanism. From Table 12 we notice that this trend is significant for AUSM (the same is true for IG).

Since the only difference between the AUSM treatments is the standby queue, it is natural to examine its utilization in the experiments. Figure 9 supplies the time series utilization of the standby queue vs. the revenue generated in our four experiments. We see that the *use* of the standby queue and revenue generation are unrelated. Thus it seems that the mere existence of the standby queue provides enough pressure to increase bids.[24]

It is clear that AUSM generates a significant amount of revenue. One question that remains is whether the increase in revenue in AUSM is offset by the increased efficiency gains so that subjects as a whole are better off participating in AUSM rather than the Random process. *For this design*, the answer is no. The Random Process generated a total of $4.50 more in total expected subject payments per period when compared with *AQ*; $3.02 when compared with *A*; and $2.84 when compared with IG.

E. Individual Choice

Random Process. As we detailed in Section VI, we would expect the Random Process to generate choices which are consistent with "scaled down" projects. Specifically, from the redemption value sheets in Appendix B, notice that if each individual chose the largest project only one order would fit per market. However, if each subject chose his smallest project everyone could fit in one of the markets. Out of the 102 orders filled in the Random Process, six orders submitted were an individual's smallest project while nine orders had the largest project submitted. Table 13 supplies the average size (X, Y) submitted by subjects over time. This table exhibits an updating phenomena on the part of the subjects.

As further evidence of this behavior notice that the valuation sheets (Appendix B) show that the project in the middle of each sheet is less than or equal to 10 units in each dimension, while any increase in the X or Y dimension from the middle results in an X or Y greater than ten, with the exception of sheet 3. Thus, if we look at the number of projects submitted whose X and Y values are less than or equal the project in the middle of the sheet or less, we find they constituted over 80 per cent of the submitted orders. Hence, the Random process tends to push projects to smaller sizes.

As a final note, *the ranking of markets by probability* (see Section VI) *was never violated by a subject in the experiments.*

AUSM. Given the rules of AUSM (ignoring the dynamics), were the final allocation and bids a Nash equilibrium? That is, using expected values, could anyone change his bid (x, y, b) without violating the AUSM rules and be made better off? The answer appears to be no. We have found little support for Nash equilibrium bidding behavior (in the expected value sense). Specifically, there are *no* Nash equilibria in any of the 20 allocations of AUSM and only four of 20 allocations in AUSM with

TABLE 13
Average Project Size Submitted per Period

Period	Mean (X, Y)
1	(9.4, 8.9)
2	(8.5, 9.9)
3	(7.7, 8.3)
4	(6.9, 6.8)
5	(8.1, 8.7)

TABLE 14
Nash Configuration

Sheet	x	y	Bid	Market	$E(\pi)$
1	12	9	220	1	\$.51
3	5	9	145	1	\$.43
4	8	12	55	2	\$.37
5	12	7	55	2	\$.28

queue. This result might be explained by risk averse behavior on the part of subjects in our experiments.

Let us consider a weaker condition of Nash equilibrium behavior. We call $(x_i^*, y_i^*, \beta_i^*)$ $i = 1, \ldots, n$ an ε–*Nash Equilibrium* if the response $(x_i^*, y_i^*, \beta_i^*)$ is i's best play given the final allocation $<\{C^{if}, b^{if}\}_{i \in K_f}>_{f=1}^{F}$ such that $[V^i(x_i^*, y_i^*) - b_i^*] \in [0, \varepsilon]$, where $(x_i^*, y_i^*) = (0, 0)$ and $b_i^* = 0$ is a possible response. If the final allocation has no responses which could make an individual at least ε better-off, then it would qualify as an ε-Nash equilibrium. Figure 11 supplies the cumulative distribution of the Nash equilibria that occurred in our experiments. Notice that for any given ε, *AQ* achieved a larger number of ε-Nash allocations than *A*. Figure 10 provides the number of best responses per period in the experiments, and Figure 12 shows the distribution of ε-Nash responses.

Do the non-Nash responses come from individuals already in a market or from those not yet in a market? The answer is that individuals in market 1 are almost always (58 out of 59) best responding. Only 27% (15/56) of the non-Nash responses come from subjects in market 2 for *A* and 33% (11/33) in *AQ*. These facts suggest subjects may be "standing pat" in market 2. However, most of the non-Nash responses are from subjects who are not yet allocated space in a market. Further, the non-Nash responses are subject specific, with 50% of the subjects supplying 71% of the non-Nash responses in *A* and 79% in *AQ*. This may support a hypothesis that some individuals are risk averse.

The main purpose of these experiments was not to test Nash behavior, but some aspects of the experiment design became clear in calculating such responses. For example, Table 14 provides a Nash equilibrium that yields one of the highest efficiency (88%) allocations *without* coalitions. The bids represent the lowest bids that maintain these as a Nash equilibrium. Notice that the expected profit is rather low for these participants. This demonstrates the sensitivity of the efficiency levels to the parameters we chose.

Iterative Groves. In terms of individual behavior we can ask two pertinent questions about the data.

(1) Did individuals bid their expected value (demand revealing) or less (for risk aversion)?

(2) Were there any discernable "strategic" bids made during a market period?

The answer to the first question is rather interesting in that many of the bids made during a market period were above expected values (40% of the bids) and this was even true on the last trial in a period (31% of the bids). This behavior did lead some individuals employing those bids to pay more than their value to get a contract. Those making such a loss (or after obtaining prices above expected values) generally did not repeat this bidding behavior. Figures 13 and 14 provide a histogram of the deviation of the winning bids from their expected value for each of our mechanisms. These distributions suggest "overbidding" in IG but "underbidding" in AUSM. Both of these results have implications for the efficiency of our mechanisms.

Two particular aspects of strategic behavior employed by subjects involved attempts to gain information about other individuals bidding behavior. First some participants would not participate in any market (a bid of 0) to see what their price would be and have no effect on the prices of individuals who were provisionally selected. Second, the participants typically used all of the possible trials, implying that the resources would be allocated in a one-shot game in the final trial.

Figure 10

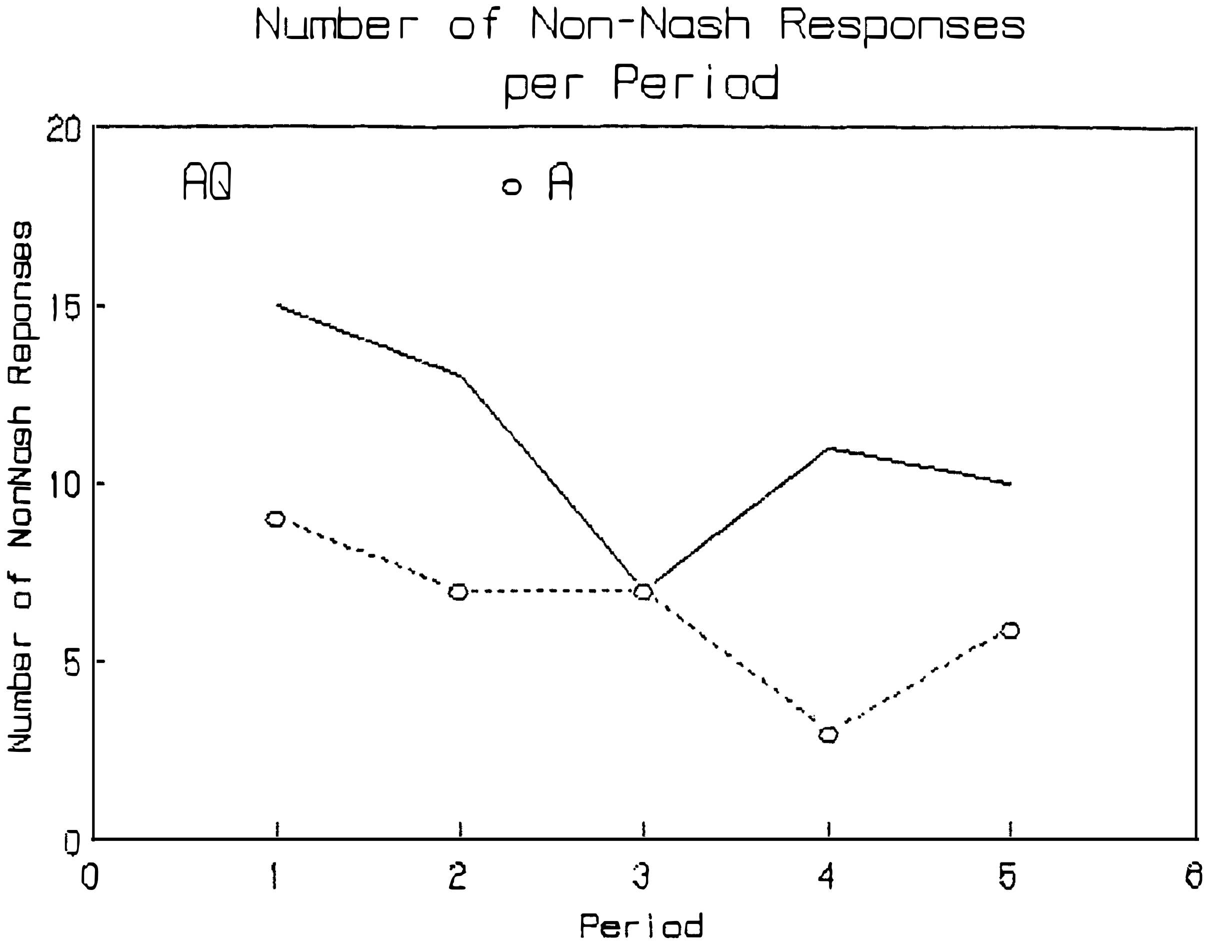

Number of Non-Nash Responses
per Period
AQ
A
Number of NonNash Reponses
0
5
10
15
20
0
1
2
3
4
5
6
Period

Figure 11

Distribution of Epsilon Nash Equilibrium

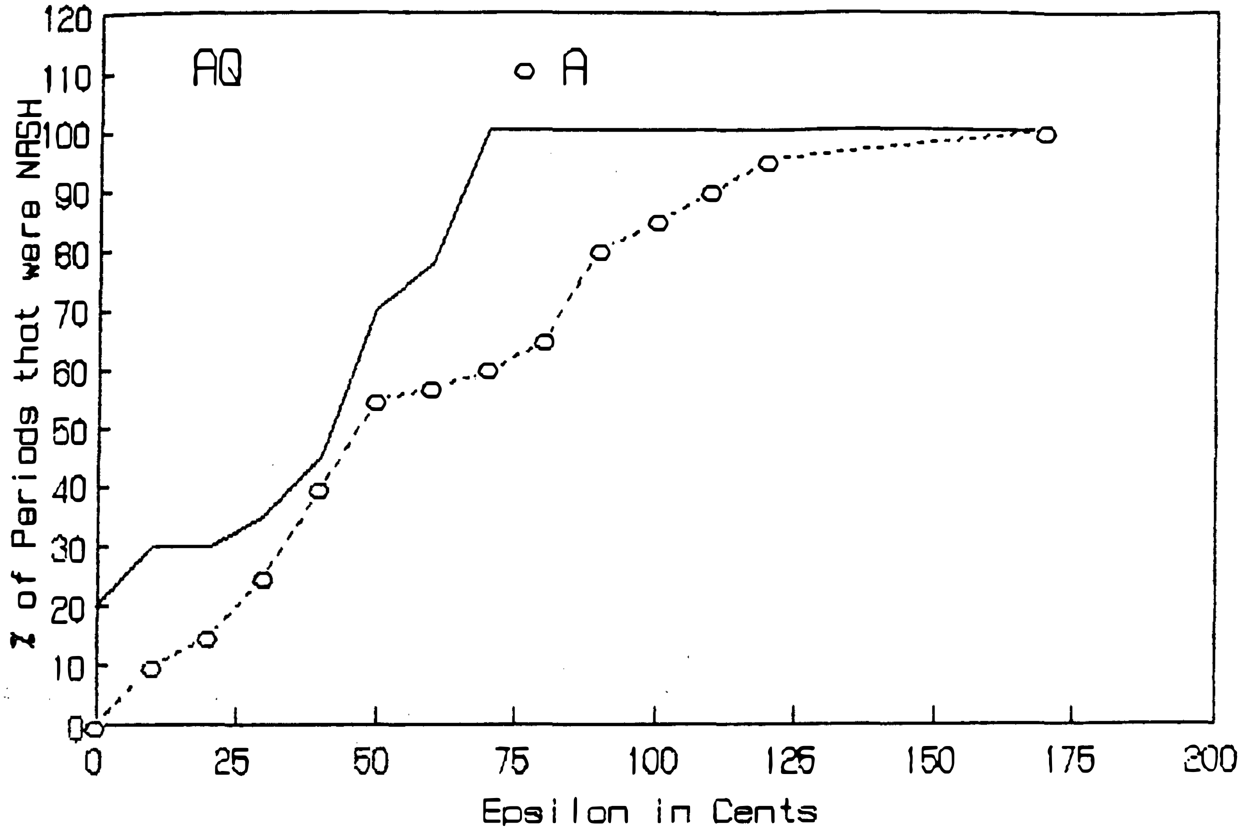


Figure 12

Distribution of Epsilon Nash Responses

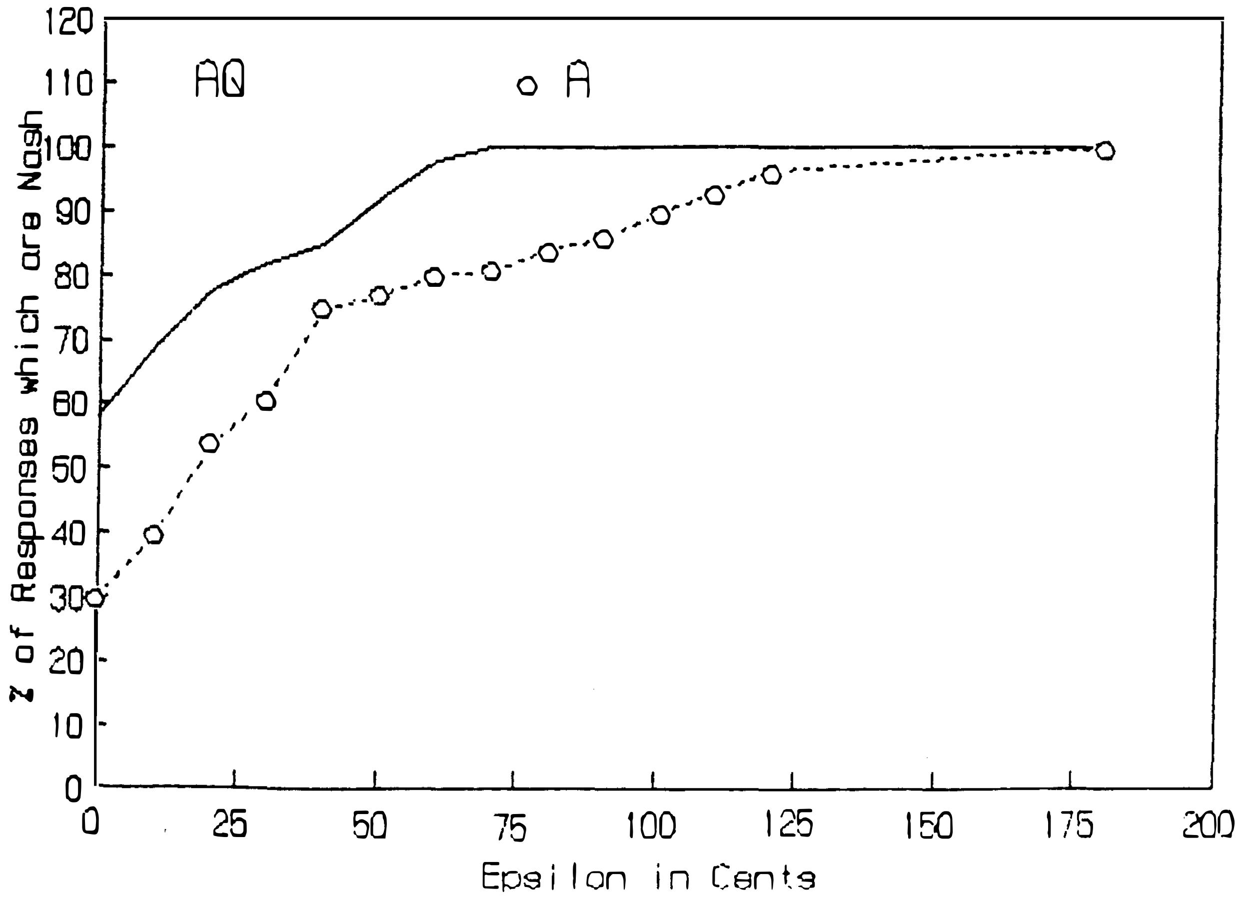


Figure 13
Distribution of Wining Bids-
Deviations from Expected Value Bidding

Market 1

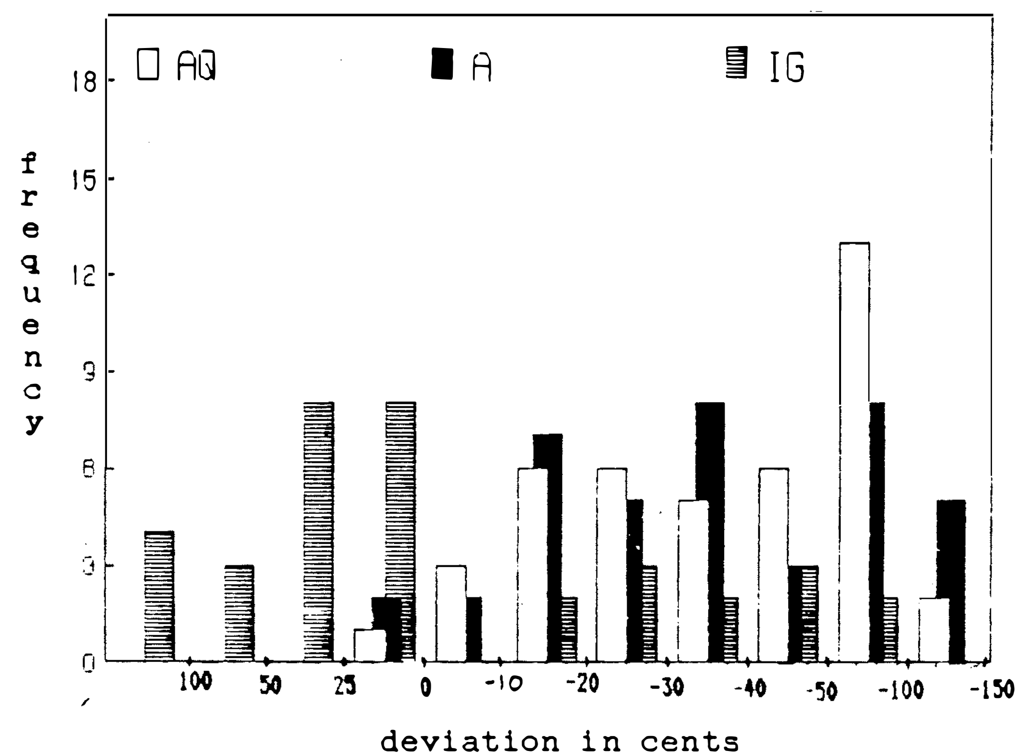
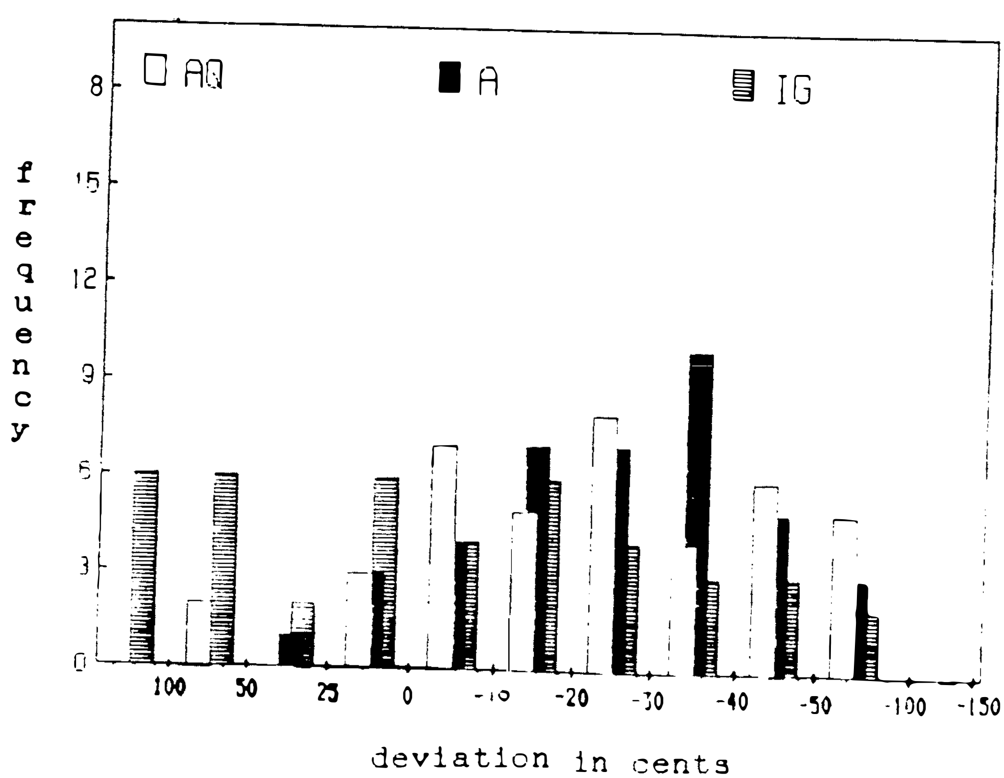


Figure 14
Distribution of Wining Bids-
Deviations from Expected Value Bidding

Market 2



(85 % of the time for market 1 and 75% of the time for market 2.) Figures 6 and 7 show that IG does poorly in utilizing the capacity of the system. In order to see if the number of trials makes a difference in the efficiency of the mechanism, we conducted an experiment with 40 trials. For the first period the efficiency was 75.5% and revenue was 250; the second period concluded with 78% efficiency and 495 for revenue. Both periods used all 40 trials.

F. Summary of Results

We have found that expected efficiency can be improved significantly, over the random allocation from first-come-first-served processes, by well-designed mechanisms. However, the mechanisms we developed do not produce outcomes near the 100% level. The reason for this phenomenon comes from three separate aspects of our experiment.

(1) Individual behavior in the AUSM mechanism reflects risk aversion. Our measures assume risk neutrality, but individual deviations from risk neutral behavior can have significant effects on expected efficiency. A better measure might account for those risk attitudes. This is particularly true given the small number of participants in our experiments.

(2) Our experiment design requires coalitions to form and cohere to secure space. We have combined a "tough" fitting problem of lumpy demands along with a problem of allocating priority. Our mechanisms have done well in finding the coalitions but they have not fared well in maintaining them to the final allocations.

(3) While the Iterative Groves mechanism is more efficient than the Random mechanism it does not produce 100% levels of efficiency. This result is in part due to the overbidding of participants. Furthermore, IG does not produce stable levels of efficiency. Superficially, this instability can be traced to the fact that the process was pushed to the final trial in many cases and thus the final bid was somewhat random.

Some other observations follow. The Random mechanism has a significant learning component with individuals scaling down projects so as to fit. There is little support for learning in our other mechanisms. Revenues were relatively high and stable for AUSM with significantly higher revenue when a queue is added. IG exhibits extremely volatile revenues especially in market 2.

However, the most important result of the experiments was the implementation of new and sophisticated processes to allocate multidimensional and uncertain outputs. These results give us confidence in our ability to establish procedures to successfully modify these mechanisms for more friendly (and hostile) environments.

IX. CONCLUSION

In this paper we have designed and analyzed two different mechanisms for solving a resource allocation problem in an environment similar in many respects to that of the space station. The two key characteristics of the environment are that i) demands are lumpy and ill-fitting and ii) supply is uncertain at the time of contracting. Both of the proposed mechanisms performed reasonably well in allocating resources, though neither could consistently generate efficiencies greater than 85%.

In terms of future research, we can imagine a number of different approaches to the environment, contracts, and mechanisms described above. Two features of the environment are immediate candidates for modification. In Figure 3 the possible configurations which generate efficiencies greater than 85% are few and far between, and hence are quite sensitive to the decisions of any one participant. Conversely, Figure 3 also indicates why it is relatively easy to achieve efficiencies between 60% and 70%. Thus, from a theoretical point of view, it would be preferable to have a more level "playing field," a fairer testbed, upon which to judge the acceptability of a particular mechanism.

A second modification to the environment would increase realism by allowing the preferences of some or all of the users to be a function of the *time* at which they are allocated resources. This would model better the importance of "launch windows" in Section III and the timing in Figure 2. Adding the time dimension to user preferences would also highlight the need for an analysis of contingent and futures contracting in allocating resources in contrast to our concentration on priority contracting. This then would allow for the comparison of mechanisms across contract types, as well as contract types across mechanisms.

A third change in the environment would alter the subjects' problems to correspond more closely to that of a NASA engineer. In particular, the payload selection process (including budgeting, peer review, and project management) might be better modeled with budget constraints on designs and payoffs for scientific benefits rather than net benefits as modeled in this paper.[25]

One change in the existing mechanisms which may lead to greater efficiencies would be to permit the users to explicitly collude in their design choices and bidding behavior. Current policies discussed in Section III with regard to Spacelab pricing have as a criterion the compatibility of a set of projects; hence the ability of users to design and promote their projects in concert seems to be a realistic consideration. Another change might be to allow separate pricing and contracting in each resource, although the lumpiness of the demands might lead to coordination difficulties.

The fundamental open question is, of course, whether or not there exist other allocation mechanisms which "do better" than those analyzed above. We leave this for others to ponder.

FOOTNOTES

* We would like to acknowledge the computer programming assistance of Peter Gray and Mark Olson. We would like to thank Bob Benson of NASA (Payload Engineering) for his patience in answering our many questions concerning Spacelab allocation procedures. Financial assistance from the Division of Humanities and Social Sciences at Caltech and from JPL is gratefully acknowledged.

1. We also detail a third mechanism which we used as a baseline in our evaluations. It can be thought of as a reasonable approximation of past NASA policy for resource allocation on the Space Shuttle and as such represents a lower bound on performance that any new mechanism must surpass.

2. In the language of technology development, we are beyond the initial concept and breadboard analysis but are not yet to the complete prototype stage, although we are currently moving our efforts in that direction.

3. For those interested in a detailed description of the space station economic environment and the history of other related NASA programs, see Banks et al [1986].

4. We will also be providing remarks concerning NASA's Spacelab program since it is the closest analogy to the proposed space station. Spacelab is a module and/or pallet configuration that fits in the Shuttle bay and provides a short duration (seven days) shirt-sleeve laboratory environment in low-earth orbit.

5. Other possible goals are discussed in Ledyard [1986].

6. There is an extensive literature on algorithms to solve "knapsack problems", which is somewhat related to our problem. We do not survey it here. The interested reader is referred to French [1982].

7. The initial problem of the airport landing slot allocation was investigated by Grether, Isaac, and Plott [1979, 1981]. Their solution relies heavily on the use of after markets to rearrange slot allocations and drive the system to an efficient allocation.

8. A typical (and obviously faulty) solution offered up by "engineers" to handle the output uncertainty and payload requirement changes for Spacelab and space station is the use of management resource reserves.

9. We will also provide footnotes describing the extension for more general contingent contracting in this environment.

10. Two generalizations could easily have been accommodated, but would have added little to the design challenge. First, one could have included a variable supply reliability in which either $y^1, y^2, \ldots,$ or $y^{(K)}$ would be supplied with probability $\Pi_1, (t_i), \ldots, \Pi_{K(t_i)}$. Second, one could have allowed the probabilities at t_2 to be conditional on the outcome at t_1.

11. We index projects by the resources they use rather than a production function. A more detailed model would let $\alpha_i \in A_i$ be the index of i 's projects, $Z^i = f\ (d_{i,} \alpha_i)$ be the output of project α_i if resources $d_i \in \mathbf{R}^k$ are used, and $W^i(Z^i, b^i)$ be i 's utility function for Z^i and payment b^i. For each d_i, let $u_i(d_i, b^i) = \max W^i(Z^i, b^i)$ subject to $Z^i = f\ (d_{i,} \alpha_i)$ and $\alpha_i \in A_i$.

12. A *contingent contract* is a triple (E, d^i, b^i), where $E \subseteq S$ is the event in which d^i must be delivered and b^i is paid whether E occurs or not. Notice that priority contracts are special contingent contracts. There are others. For the example in Figure 2, the contingent contract $(3, d^i, b^i)$ implies i receives (d_1^i, d_2^i) if state 3 occurs. Feasibility implies $d_i^i = 0$ since $y_1(3) = 0$. A contract $(\{1,2\}, (d^i, 0), b^i)$ will give i an amount d_1^i in period 1 if and only if y_1 is supplied in period 1. The simplest *complete* set of contingent contracts is $\{(s, d^i, b^i) s \in S\ \}$, which is the , standard Arrow-Debreu set of contingent markets. This set is complete in the sense that all achievable consumption plans can be attained through some combination of these contracts. For example, i can insure consumption of d^i in period 2 of Figure 2, if it is available, by contracting for $(1, d^i, b_1^i)$ and $(3, d^i, b_3^i)$ where $d = (0, d^i)$.

13. The model can be easily adapted to risk-averse suppliers and to contracts in which b^i is paid only if delivery occurs. We leave this exercise to the interested reader.

14. For contingent contracts we would have three markets which correspond to all the non-zero states in Figure 2. That is, market 1 would correspond to g in period 1; market 2 for g in both periods; and market 3 for g in period 2 only. Combinations of contracts in market 1 and 3 and market 2 and 3 are feasible with contingent contracts.

15. With a set of contingent contracts, the sequence of events in the tree structure of Figure 2 is explicitly recognized. For this baseline mechanism, the three outcomes (g, g), (g, n) and (n, g) are to be allocated randomly. Participants were asked to submit an order with an x and y configuration along with a preference ranking over the five consistent portfolios (g, g), (g, n) and (n, g) and $\{(g, n)$ and $(n, g)\}$, $\{(g, g)$ and $(n, g)\}$. These markets were labeled (1), (2), (3), (1 and 3), and (2 and 3) respectively. The orders were then collected and randomly selected one at a time and placed in the first available market with available capacity according to the ranking on the order form. When all the capacity or orders were exhausted, a die was rolled twice. If the numbers 1 through 4 appeared on the first roll, the orders in market 1, and market

1 and 3 would be filled. If the numbers 1 through 4 appeared on the first roll and 1 through 3 appeared on the second roll, the orders in market 2, and market 2 and 3 would be filled. If the numbers 5 or 6 appeared on the first roll and the numbers 1 through 3 appeared on the second roll, the orders in market 3, and market 2 and 3 would be filled. If a participant's order was filled, he/she would receive the value associated with the configuration ordered.

16. A fixed fee could have been levied which we do not think would have affected offered proposals, but could possibly have affected participation.

17. The plausibility of this can be seen by assuming that d^i can be chosen continuously. An agent facing the random mechanism will choose d^i to maximize $\theta^i(d,f)u^i(d^i,0)$. That is, if d^{*i} is i's choice then d^{*i} satisfies

$$[\partial u^i(d^*,0)/\partial d^i]\cdot\theta^i(d^*,f) = -[\partial\theta^i(d^*,f)/\partial d^i]\cdot u^i(d^{*i},0).$$

On the other hand the project with the largest payoff, $\hat{d}^i$, satisfies $[\partial u^i(\hat{d}^i,0)/\partial d^i]=0$. Since $\partial\theta^i/\partial d^i<0$ it follows that $[\partial u^i(d^{*i},0)/\partial d^i] > [\partial u^i(\hat{d}^i,0)/\partial d^i]$. Therefore, $d^{*i}<\hat{d}^i$. (Note that this is true in all dimensions of d^i.)

18. There are two plausibility arguments one can use to support the remark that users confronted with the random mechanism will choose inefficiently sized projects. First, suppose that one could omnisciently and simultaneously pick the size of all projects $(d^i,\ldots,d^N)$ to maximize the expected benefits of using the random mechanism, $\Sigma_i\theta^i(d,f)u^i(d^i,0)$. The choices, d^{**} would satisfy the N equations:

$$[\partial\theta^j(d^{**},f)/\partial d^j]u^j(d^{**j},0)+\theta^j(d^{**},f)[\partial u^j(d^{**j},0)/\partial d^j] =$$
$$-\Sigma_{k\neq j}[\partial\theta^k(d^{**},f)/\partial d^j]u^k[d^{**j},0].$$

On the other hand, users selecting d^i independently will choose d^{*i} so that the left hand side of these equations are zero. Further, it seems likely that if d^{**j} is small then $\partial\theta^k(d^{**},f)/\partial d^j<0$ and if d^{**j} is large then $\partial\theta^k(d^{**},f)/\partial d^j>0$. The former because small projects are likely to fit in and, if they do, the bigger they are the less room they leave for others. The latter because large projects are less likely to fit in and the bigger they are the less likely it is, leaving more room for others. Therefore if d^{**j} is small then $\partial[\theta^j(d^{**},f)u^j(d^{**j},0)]/\partial d^j <$ $\partial[\theta^j[d^*,f]\cdot u^j(d^{*j},0)]/\partial d^j$. If, in the move from d^{**} to d^*, $\theta^j(d,f)$ behaves reasonably then this implies that $d^{*j}>d^{**j}$. That is, the agent chooses a project size larger than that one would choose to maximize aggregate benefits. If d^{**j} is large, the opposite conclusion holds. The second plausibility argument is not conclusive since it rests on some shaky calculations; but it is suggestive. We provide the calculation for participant 1. Suppose that if the small project, $(x,y)=(4,3)$, is chosen then it fits in market 1 if selected first, second or third and in market 2 if selected first through fifth. Then $\theta=\frac{1}{2}\rho_1+\frac{1}{3}\rho_2=\frac{1}{2}$. Suppose if the large project, $(x,y)=(12,13)$ is chosen it fits in 1 if chosen first and in 2 if chosen 2nd or 3rd. Then

$\theta = \frac{1}{6}\rho_1 + \cdot \frac{1}{3}\rho_2 = \frac{1}{6}$. Finally suppose for the medium size, $(x, y) = (7, 9)$, $\theta = \frac{1}{3}\rho_1 + \frac{1}{3}\rho_2 = \frac{1}{3}$. Under these assumptions the project that maximizes $\theta \cdot u$ is the medium size where $\theta u = 75$. A similar calculation works for all participants.

19. Of course, if enough contingent bids could be submitted in a sealed-bid, it could mimic an iterative process, but in an infomationally more complex manner.

20. If omitted users could replace just the marginal units of those users in the potential allocation, then it would not be costly to "bump" part of a large user. To do this, however, users would have to be allowed to express a bid for each unit they wish to buy, yielding an entirely different mechanism.

21. For contingent contracts:
    a) Three markets are employed in accordance with the tree structure found in Figure 2. Orders could be submitted for markets 1, 2, or 3 separately or the market combinations (1 and 3), and (2 and 3). Subjects could not have orders simultaneously in markets 1 and 2. The last order submitted by a subject replaced all existing orders of the subject. Finally, if a subject had orders in two markets the orders had to have the same configuration.
    b) The costs in a market period for a subject was the sum of his bids for each market where he has orders at the market close. Earnings for a market period would be equal to the redemption value of the orders filled minus costs.

22. Given that the environment we are investigating involves the allocation of an uncertain supply, questions concerning risk attitudes naturally arise. In particular, subjects will be obtaining queue positions and paying money for outputs which are random. They are buying lotteries. We have chosen not to attempt to control for risk attitudes in testing the mechanisms for two reasons. First, in practice users of space station will have varied risk attitudes and mechanisms must perform well in that situation. Second, techniques to induce or control for risk attitudes in the laboratory may provide assistance for tests with specific risk preference contours (see Berg, et. al, [1986] and Roth and Malouf [1979]); however, given the results from Cox, Smith, and Walker [1985], we are dubious of the use of such techniques for controlling subject-risk attitudes in mechanism design experiments.

23. The Table below provides the descriptive statistics for the treatment of contingent contracts across mechanisms (except for AUSM with queue and Iterative Groves). The main aspect of these data to notice is that the introduction of these contracts does not improve efficiency (see Figures 5 and 6 in Appendix D).

Efficiency by Mechanism—Contingent Contracts				
Mechanism	μ	σ	v	Range
Random	63	9	.14	[48, 73]
AUSM	78	3	.04	[73, 81]

24. The table below supplies the descriptive statistics for the revenue generated by contingent contracts in AUSM without a queue. We note that these preliminary data suggest that the use of contingent contracts generates more revenue. In addition, while market 1 has a relatively stable revenue component, markets 2 and 3 exhibit a higher variation in their revenue patterns.

Revenue				
Market	μ	σ	v	Range
Market 1	273	33	.12	[215, 315]
Market 2	137	30	.22	[90, 175]
Market 3	82	23	.28	[55, 125]
Total Revenue	492	70	.14	[390, 585]

25. We would change the model in footnote 11 as follows: Let B^i be i's budget as determined by NASA and Congress and $W^i(Z^i)$ be the utility for the scientific returns Z^i and let $c^i(d_i, \alpha_i)$ be the cost of design and construction of project (d_i, α_i). Now let $U^i(d_i, B^i - b^i) = MAX\ W^i(Z^i)$ subject to $b^i + c^i(d_i, \alpha_i) \le B^i$, $Z^i = f(d_i, \alpha_i)$, and $\alpha_i \in A_i$. This change in U^i could be easily accommodated.

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APPENDIX A
SPACELAB DECISION FLOW

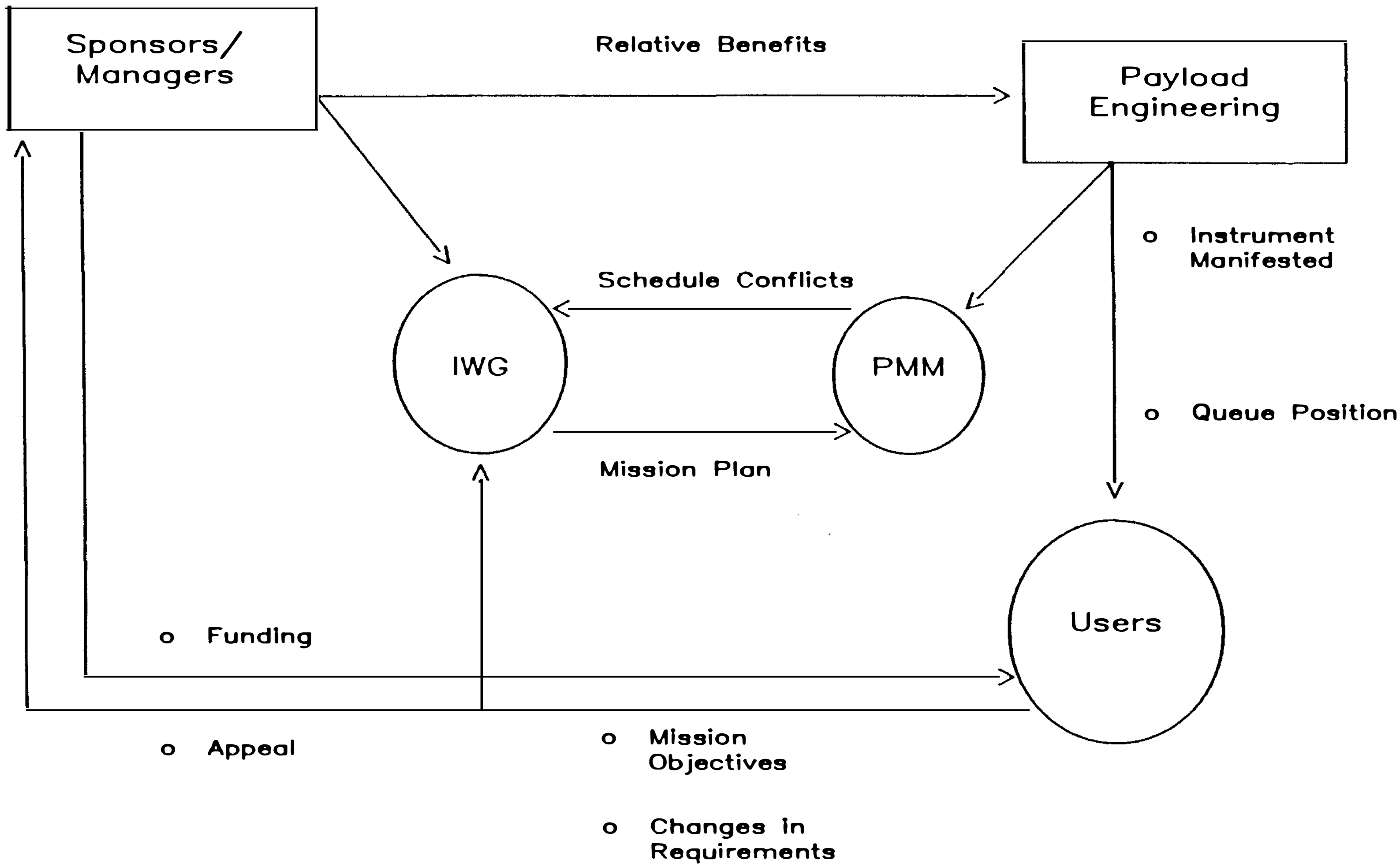


Figure 1. Spacelab Decision Flow

APPENDIX B
REDEMPTION VALUE SHEETS AND SCREEN DISPLAY

Valuation Sheet 1

X \ Y	3	9	13
4	100	150	175
7	175	225	250
12	250	325	335

Valuation Sheet 2

X \ Y	6	10	14
3	125	150	175
9	175	190	200
15	200	225	250

Valuation Sheet 3

X \ Y	2	4	9
3	75	100	125
5	100	200	225
12	175	250	275

Valuation Sheet 4

X \ Y	8	10	12
6	100	150	200
8	150	200	275
12	175	250	300

Valuation Sheet 5

X \ Y	7	10	13
6	175	225	250
9	225	275	300
12	250	300	325

Valuation Sheet 6

X \ Y	7	9	11
7	75	150	175
9	125	175	200
11	150	200	225

ITERATIVE GROVES SCREEN DISPLAY
FOR BUYER 2

MARKET 1	TRIAL 1	
BUYER	X	Y
1	7	10
5	9	6
4	4	4
b1=0		P1=200
MARKET 1	TRIAL 2	
BUYER	X	Y
1	7	10
5	9	6
b2=0		P2=200
Excess	4	4

MARKET 2	TRIAL 1	
BUYER	X	Y
6	6	6
2	**8**	**12**
b1=20		**P1=10**
MARKET 2	TRIAL 2	
BUYER	X	Y
6	6	6
2	**8**	**12**
b2=20		**P2=10**
Excess	6	2

> Enter quantity of X desired ___

APPENDIX C
INSTRUCTIONS

INSTRUCTIONS

(This portion is the same for all mechanisms)

You are about to participate in an experiment designed to provide insight into certain features of decision processes. If you follow the instructions carefully and make good decisions, you might earn a considerable amount of money. You will be paid in cash.

In this experiment we are going to conduct a market in which you will make decisions which will be used to determine the market outcomes. You will be given a Redemption Value Sheet, which describes the value to you of the decisions you might make. <u>You are not to reveal this information to anyone</u>. It is your own private information.

The type of currency used in this market is francs. All transactions will be in terms of francs. Each franc is worth _____ dollars to you. Do not reveal this number to anyone. At the end of the experiment your francs will be converted into dollars at this rate, and you will be paid in dollars.

On your Redemption Value Sheet you have one project which has 9 possible X and Y configurations associated with it along with a redemption value stated in francs. Suppose for example that your Redemption Value Sheet were as follows:

Y / X	3	6	12
5	100	200	300
10	200	400	500
15	300	450	550

Then for your project with the configuration X=5 and Y=12, you would have a redemption value of 300 francs; for your project with configuration X=10 and Y=6 you would have a redemption value of 400 francs.

Within each market period there will be a total of ___ markets with a fixed capacity of 20 units of X and 20 units of Y in each market to be allocated to participants. Your amount of X and Y and the earnings you will receive will be determined using the following process.

(For the Iterative Groves mechanism we used)

All communication during the market period will conducted through your computer terminal. The experiment will consist of several market periods. Each market period will be composed of trials in which you will submit an order. An order consists of a configuration, a market, and a bid for the market. You can submit an order during a trial by following the instruction prompts on your computer screen. The first prompt will ask you for a configuration of X and Y. <u>You must then enter one of your 9 choices</u>. Next you will be asked if you want to enter a bid for market 1; if you answer yes (y), you will be asked for your bid in francs. If you answer no (n), it will proceed to market 2 and ask you if you would like to bid. Thus, for a trial in a market period you cannot simultaneously have a bid in markets 1 and 2.

EXAMPLE

Enter quantity of X desired: 7
Enter quantity of Y desired: 12
Do you want to order in market 1? n
Do you want to order in market 2? y
Enter bid in market 2: 150
Do you confirm X = 7 Y = 12 B1 = 0 B2 = 150 ? y

Thus, in this example a bid of 150 francs was placed in market 2 for the configuration X=7 and Y=12. The only restriction you have on the bids you submit for a market during a period is that it be greater than or equal to zero. After each participant has placed an order during a trial, a set of provisional configurations will be selected for each market by finding the largest sum of bids submitted for that market for which the sum of the corresponding configurations do not exceed the capacity constraints (X = 20, Y = 20). Each individual will then be given the information as to which participants are provisionally selected in each market and their configurations. In addition, each participant will receive a price for each market. If you are one of the participants that are provisionally selected in a market, your price will be calculated as follows:

[Maximum of the sum of bids (without your bid) submitted for that market for which the corresponding total configurations (without your configuration) does not violate the capacity constraint] -

[Sum of bids (excluding your bid) of the provisional configurations]

If your configuration is not one of the provisional configurations in a market, then you will receive a price which indicates the minimum bid you could have submitted in that market and have had your order be one of the provisional configurations in that market.

EXAMPLE

	Market 2			
Participant	X	Y	Bid	Price
*1	10	10	200	160
2	15	10	160	200
3	10	15	170	350
*4	5	10	150	0
6	11	5	100	200

In this example, we see that participants 1 and 4 have provisional configurations in this market because their combined requests of X=15 and Y=20 do not violate the capacity constraints, and their sum of bids of 350 francs is the largest such sum. The price for participant 1 was calculated by: [310] - [150] = 160 as per the equation above. Similarly, the price for participant 4 was calculated by: [200] - [200] = 0. Notice that in either case the price does not depend on the participant's bid.

For an individual who is not in the provisional configuration in this example, such as participant 3, we see that to be in the provisional set he/she must bid 350 francs since the configuration he/she submitted cannot fit with any other order.

The provisional configurations in the markets will obtain their allocations if the same participants and configurations occur for ___ straight trials (Rule A), or the trials in the market period are exhausted. A total of ___ trials for each market period will be allowed. Market 1 will close after ___ trials, and market 2 after ___ additional trials. That is, if Rule A is not activated after ___ trials the provisional allocations in market 1 will be chosen, and after ___ trials the orders in market 2 will be chosen. After the process stops in a period by either of the conditions a die will be rolled. If the numbers _____ through ____ appear the orders in market 1 will be filled. If the numbers _____ through ____ appear the orders in market 2 will be filled.

Each participant has been given _____ francs of working capital. To determine your <u>costs</u> for the market period, sum up your prices in those markets for which you have obtained an allocation at the market close. If your order is filled, then your earnings will be equal to your redemption value minus your costs. If your order is not filled, you must subtract your costs from your working capital. If you do not obtain an allocation in a market for the period, you will receive zero earnings for the period. You should record your earnings on your Record of Earnings sheet located in the back of your folder. At the beginning of a market period you will be assigned a new Redemption Value Sheet from which to make your decisions. The Redemption Value Sheet will not be the same for all participants. Feel free to earn as much as you can. Are there any questions?

(For the ASUM-Bulletin Board with Queue we used)

When the market opens you will be able to submit an order consisting of a market or the Standby Queue, a configuration, and a bid in francs. Orders will be taken one at a time and posted on the board. You can submit an order by raising your hand and after you are identified, you can submit one order. Your order will be accepted if:

a) It can fit in the available capacity of the market requested, or

b) It can displace existing orders with lower bids, or

c) The Standby Queue is requested.

If place an order in the Standby Queue you must also identify the market for which the order is to be placed on standby. However, you can have only one order in the markets at any one time. Thus, you can have an order in Market 1 or 2 but not both Markets 1 and 2 simultaneously. You can have as many orders as you want in the Standby Queue.

Suppose for example, that the fixed capacity was X = 20 and Y = 20, and there were 2 markets, and the existing orders , none of which are yours, were as follows:

	Market 1			Market 2			Standby Queue			
	X	Y	Bid	X	Y	Bid	X	Y	Bid	Market
	11	9	1100	7	5	500	5	5	400	1
	5	7	1000							
Available Capacity	4	4		13	15					

If you want to submit an order that has quantities X = 4 and Y = 6, you can order space in Market 2 or the Standby Queue and submit any nonnegative bid, or you can order space in Market 1 and displace the X = 5 and Y = 7 order with a bid greater than 1000 francs. Furthermore you can combine your bids with orders in the Standby Queue that were not submitted by you to displace existing orders in Markets 1 and 2 if the entire order can fit and the total bid is greater than the total displaced orders bids. For example, you could have made a bid greater than 600 francs and combined that with the existing 400 franc bid in the Standby Queue and displace the X = 5 and Y = 7 order in Market 1 since you both can fit. In the event that more than one existing order can be displaced by your bid the order with the lowest bid will be the one displaced. If one of your orders in the Standby Queue is combined with another order, then any order you have standing in a market is canceled.

If you have an order in a market you can change it only if you increase your bid. If you increase your bid you can:

a) Move your configuration to another market if you can fit or displace orders with lower bids and/or

b) Change your configuration if it fits. However, if you do not move your configuration to another market you must place a bid higher than the orders you are displacing including your Standing Order.

Your bid change must be greater than _______ francs to be accepted. Once you have an order in a market you cannot withdraw it. However, you can withdraw orders from the standby queue.

In the event that your order is displaced you can reorder through the process described above. The process will stop when there are no new orders or order changes (increased bids) within _______ seconds of the last order submitted. The orders left standing on the board in Markets 1 and 2 when the process stops are the only orders that can be filled. However, there is a chance that the orders at the market close will not be filled. After the process stops a die will be rolled. The orders in Market 1 will be filled if any of the numbers _____ through ______ appear. The orders in Market 2 will be filled if any of the numbers ______ through ______ appear.

Each participant has been given _______ francs of working capital. If your order is filled your earnings will be equal to your redemption value minus your bid. If your order is not accepted you must subtract your bid from your working capital. If you did not get in a market you will receive zero earnings for the market period. You should record your earnings on your Record of Earnings Sheet located in the back of your folder. Your earnings plus your remaining working capital are yours to keep. At the beginning of a market period you will be assigned a new Redemption Value Sheet from which to make your decisions. The Redemption Value Sheet will not be the same for all participants. Feel free to earn as much as you can. Are there any questions?

(For the AUSM-Bulletin Board we used)

When the market opens you will be able to submit an order consisting of a market, a configuration, and a bid in francs. Orders will be taken one at a time and posted on the board. You can submit an order by raising your hand and after you are identified, you can submit one order. Your order will be accepted if:

a) It can fit in the available capacity of the market requested, or

b) It can displace existing orders with lower bids.

However, you can only have one order standing on the board at any one time. Thus you can have an order in Market 1 or 2 but both Markets 1 and 2 simultaneously.

For example, suppose the fixed capacity was X = 20 and Y = 20, and there were two markets, and the existing orders none of which are yours were as follows:

	Market 1			Market 2		
	X	Y	Bid	X	Y	Bid
	10	9	1100	7	5	500
	5	7	1000			
Available Capacity	4	4		13	15	

If you want to submit an order that has quantities X = 4 and Y = 6 you can either order space in Market 2 and submit any nonnegative bid, or you can order space in Market 1 and displace the X = 5, Y = 7 order with a bid greater than 1000 francs. In the event that more than one existing order can be displaced by your bid the order with the lowest bid will be the one displaced.

If you have an order standing on the board you can change it only if you increase your bid. If you increase your bid you can:

a) Move your configuration to another market if you can fit and/or

b) Change your configuration if it fits. However, if you do not move your configuration to another market you must place a bid higher than than the orders you are displacing including your standing order. Your bid change must be greater than ______ francs to be accepted. Once you have an order in a market you cannot withdraw it.

In the event that your order is displaced you can reorder through the process described above. The process will stop when there are no new orders or order changes (increased bids) within _______ seconds of the last order submitted. The orders left standing on the board in Markets 1 and 2 when the process stops are the only orders that can be filled. However, there is a chance that the orders at the market close will not be filled. After the process stops a die will be rolled. The orders in Market 1 will be filled if any of the numbers _____ through ______ appear. The orders in Market 2 will be filled if any of the numbers ______ through ______ appear.

Each participant has been given _______ francs of working capital. If your order is filled your earnings will be equal to your redemption value minus your bid. If your order is not accepted you must subtract your bid from your working capital. If you did not get in a market you will receive zero earnings for the market period. You should record your earnings on your

Record of Earnings Sheet located in the back of your folder. Your earnings plus your remaining working capital are yours to keep.

At the beginning of a market period you will be assigned a new Redemption Value Sheet from which to make your decisions. The redemption value sheet will not be the same for all participants. Feel free to earn as much as you can. Are there any questions?

(For the Random Process we used)

At the beginning of the market period you will send in your order for an X and Y configuration you would like by submitting an order form, and a ranking of your preferences for Markets 1 and 2. That is, you cannot place a preference ranking for Markets 1 and 2 simultaneously. Order forms can be found in the back of your folder. To submit an order just place your X and Y configuration found on your Redemption Value Sheet on your order form with a ranking of the markets. For example, suppose you want to place an order for a configuration on your redemption value sheet that quantities of X = 9 and Y = 14, and you wanted the market rankings 2 and 1, then you would send in an order form with the following information:

ORDER FORM

Ranking

X = _________ Y = _________ _________

____

You can submit one order.

After all the orders have been collected we will randomly select the orders and place them in the first available market with capacity available according to the ranking on the order form as they are drawn. After we have exhausted all the orders or the capacity in each market we will determine the orders that are filled by rolling a die twice. If the numbers ______ through ______ appear on the first roll the orders in Market 1 will be filled. If the numbers _____ through _____ appear then the orders in market 2 will be filled.

Your earnings for the market period will be equal to your redemption value if your order is filled, otherwise your earnings will be zero. You should enter earnings for the market period on your Record of Earnings Sheet. Your total earnings over all the market periods are yours to keep.

At the beginning of a market period you will be assigned a new Redemption Value Sheet from which to make your decisions. The redemption value sheet will not be the same for all participants. Feel free to earn as much as you can. Are there any questions?

(For the Random Process with Contingent Contracts we used)

At the beginning of the market period you will send in your order for an X and Y configuration you would like by submitting an order form, and a ranking of your preferences for Markets 1, 2, 3, 1 and 3, and 2 and 3. That is, you cannot place a preference ranking for Markets 1 and 2 simultaneously. Order forms can be found in the back of your folder. To submit an order just place your X and Y configuration found on your Redemption Value Sheet on your order form with a ranking of the markets. For example, suppose you want to place an order for a configuration on your redemption value sheet that quantities of X = 9 and Y = 14, and you wanted the market rankings 2 and 3, 1, 3, 1 and 3, and 2, then you would send in an order form with the following information:

ORDER FORM

X = ________	Y = ________	Ranking
		________
		________
		________
		________
		________

You can submit one order.

After all the orders have been collected we will randomly select the orders and place them in the first available market with capacity available according to the ranking on the order form as they are drawn. After we have exhausted all the orders or the capacity in each market we will determine the orders that are filled by rolling a die twice. If the numbers ______ through ______ appear on the first roll the orders in Market 1 will be filled. If the numbers _____ through _____ appear on the first roll and the numbers _____ through _____ appear on the second roll the orders in Markets 1 and 2 will be filled. If the numbers ______ through _____ appear on the first roll and the numbers ______ through _____ appear on the second roll the orders in Market 3 will be filled.

Your earnings for the market period will be equal to your redemption value if your order is filled, otherwise your earnings will be zero. You should enter earnings for the market period on your Record of Earnings Sheet. Your total earnings over all the market periods are yours to keep.

At the beginning of a market period you will be assigned a new Redemption Value Sheet from which to make your decisions. The redemption value sheet will not be the same for all participants. Feel free to earn as much as you can. Are there any questions?

Review Quiz [IG]

Suppose the following information for trial z in a market period was on your screen:

Market 1	Trial z	
Buyer	X	Y
1	7	10
5	9	6
4	4	4
bz = 0	Pz = 200	

Market 2	Trial z	
Buyer	X	Y
6	6	6
2	8	12
bz = 50	Pz = 10	

1. If these same buyers and associated (x,y) configurations were to be the same for the next ____ trials would the process stop? What if trial z were trial ___?

2. If you are buyer 2 and you were to submit a bid of 200 francs in market 1 in the next trial for your configuration x = 8, y = 12, will you get into market 1? What will happen to your order in market 2?

3. If the market closed with the orders in this example and the roll of the die were a 4, what would be the earnings for buyer 5 if his redemption value were 900 francs and his price were 200 francs? What would be the earnings for buyer 6 if his redemption value were 900 francs and his price were 20 francs?

REVIEW QUIZ [A]

Suppose the existing orders in the markets (none of which are yours) were as follows:

	Market 1			Market 2		
	X	Y	Bid	X	Y	Bid
	7	10	600	6	6	500
	9	6	500	8	12	400
	4	4	400			
Available Capacity	0	0		6	2	

1. If you wanted to submit an order with a configuration of X= 6 and Y = 6 what is the lowest bid you could make and get into a market?
2. If you wanted to submit a configuration of X = 8 and Y = 9 what is the lowest bid you could make and obtain a place in Market 1? In Market 2? What happens to the displaced orders?
3. If the X = 6 and Y = 6 configuration in Market 2 is your order and you have a possible X = 4 and Y = 4 configuration could you move your order to Market 1? If so what is the smallest bid you could make?
4. If the market closed with the orders in this example and the roll of the die were a 4 what would be the earnings for the X = 9 and Y = 6 configuration in Market 1 if its redemption value were 900 francs? What would be the earnings for the X = 6 and Y = 6 configuration in Market 2 if its redemption value were 900 francs?

REVIEW QUIZ [AQ]

Suppose the existing orders in the markets (none of which are yours) were as follows:

	Market 1			Market 2			Standby Queue			
	X	Y	Bid	X	Y	Bid	X	Y	Bid	Market
	7	10	600	6	6	500	3	3	300	1
	9	6	500	8	12	400	4	5	200	2
	4	4	400				15	10	400	1
Available Capacity	0	0		6	2					

1. If you wanted to submit an order with a configuration of X= 6 and Y = 6 what is the lowest bid you could make and get into a market?
2. If you wanted to submit a configuration of X = 8 and Y = 9 what is the lowest bid you could make and obtain a place in Market 1? In Market 2? What happens to the displaced orders?
3. If the X = 6 and Y = 6 configuration in Market 2 is your order and you have a possible X = 4 and Y = 4 configuration could you move your order to Market 1? If so what is the smallest bid you could make?
4. If the market closed with the orders in this example and the roll of the die were a 4 what would be the earnings for the X = 9 and Y = 6 configuration in Market 1 if its redemption value were 900 francs? What would be the earnings for the X = 6 and Y = 6 configuration in Market 2 if its redemption value were 900 francs? What would be the earnings of the X = 3 and Y = 3 configuration in the Standby Queue if its redemption value were 500 francs?

APPENDIX D
TIME SERIES FIGURES FOR EACH EXPERIMENTAL TREATMENT

Figure 15 Times Series of Efficiency
ASUM with Queue (Priority Contracts)

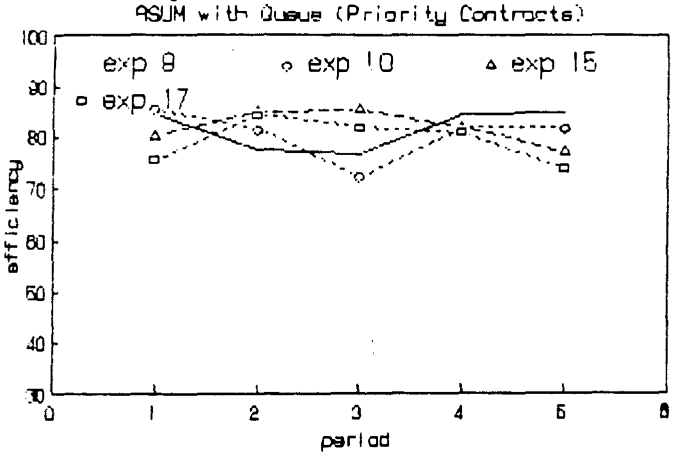


Figure 16 Time Series of Efficiency
ASUM (Priority Contracts)

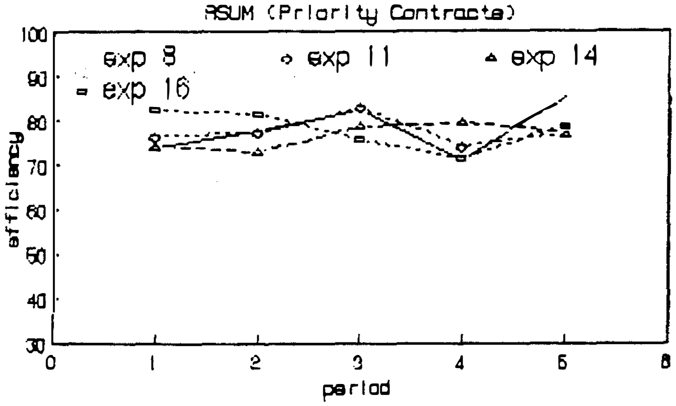


Figure 17 Time SEries of Efficiency
IG (Priority Contracts)

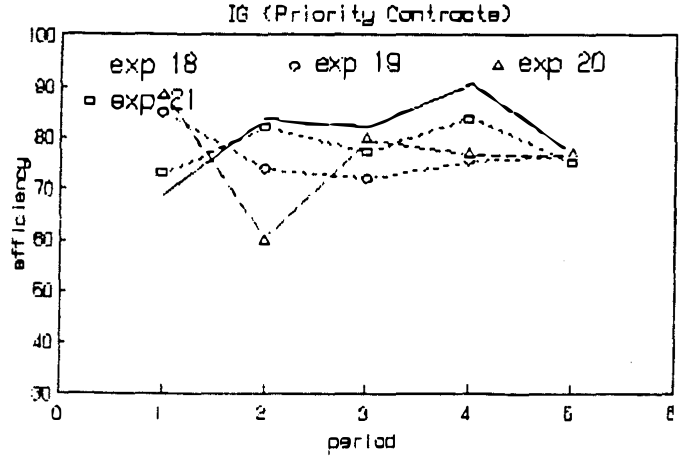


Figure 18 Time Seriese of Efficiency
Random Mechanism (Priority Contracts)

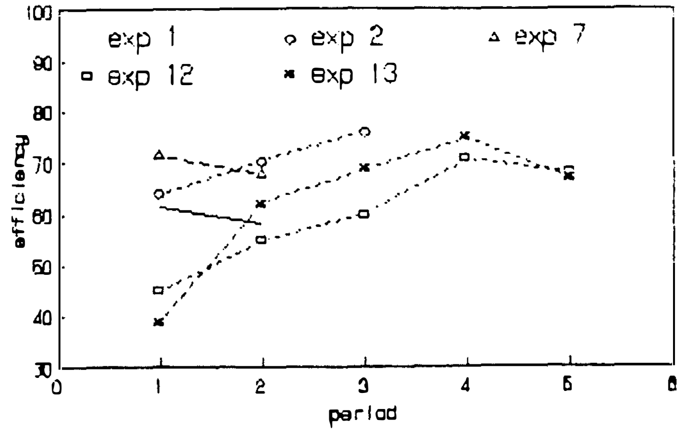


Figure 19 Time Series of Efficiency
ASUM (Contingent Contracts)

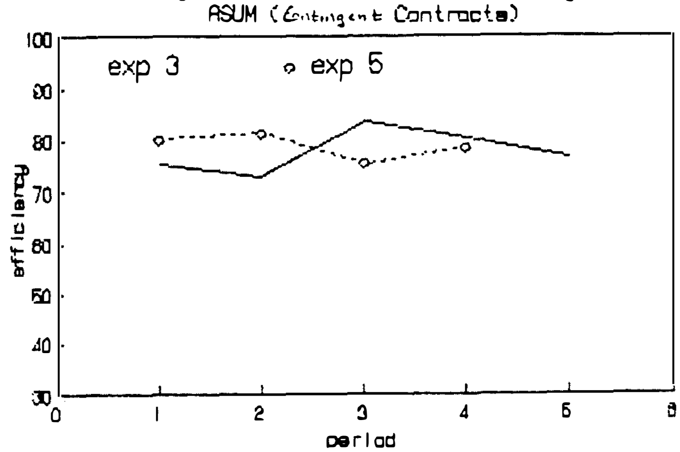
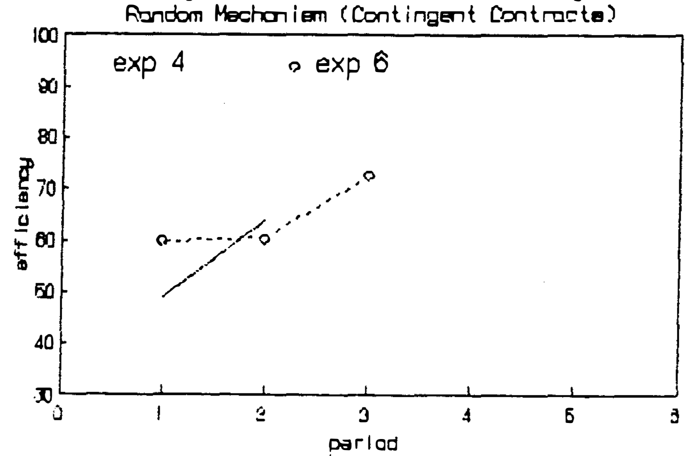


Figure 20 Time Series of Efficiency
Random Mechanism (Contingent Contracts)



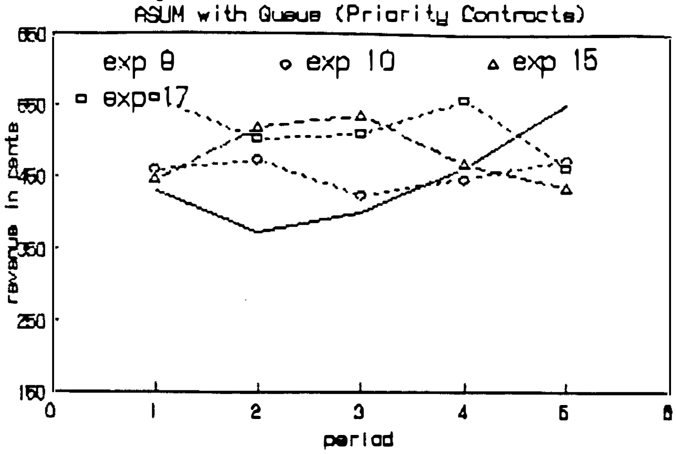


Figure 21 Time Series of Total Revenue
ASUM with Queue (Priority Contracts)

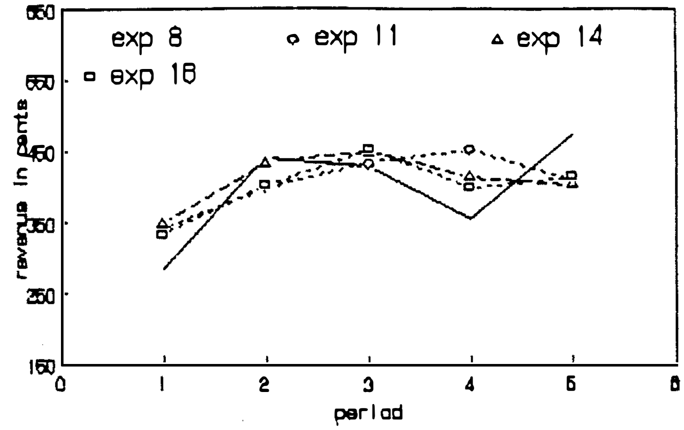


Figure 24 Time Series of Total Revenue
ASUM (Priority Contracts)

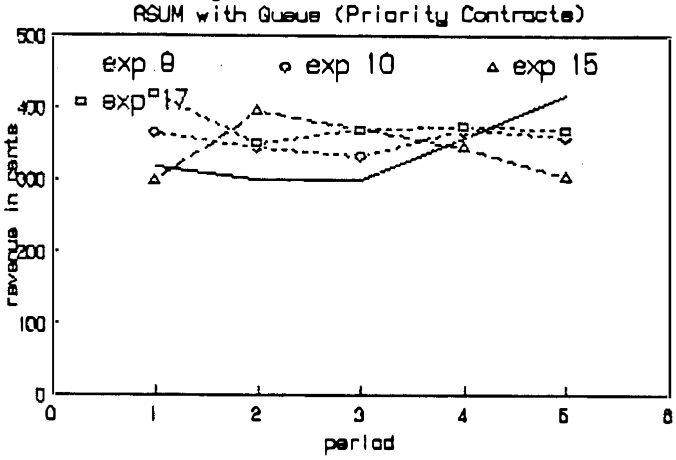


Figure 22 Revenue for Market 1
ASUM with Queue (Priority Contracts)

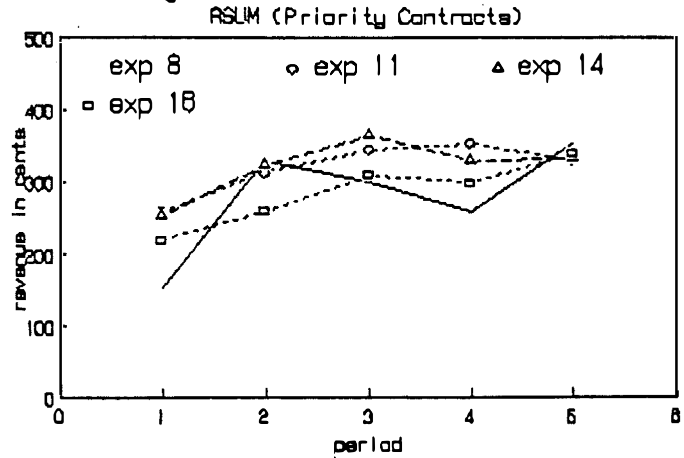


Figure 25 Time Series Revenue Market 1
ASUM (Priority Contracts)

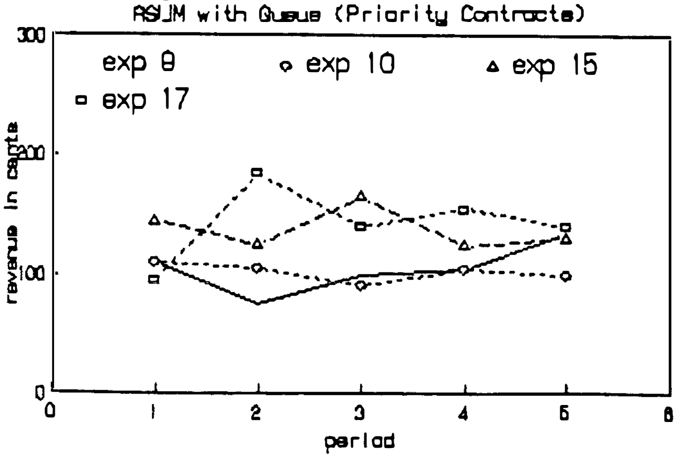


Figure 23 Time Series of Revenue Mkt 2
ASUM with Queue (Priority Contracts)

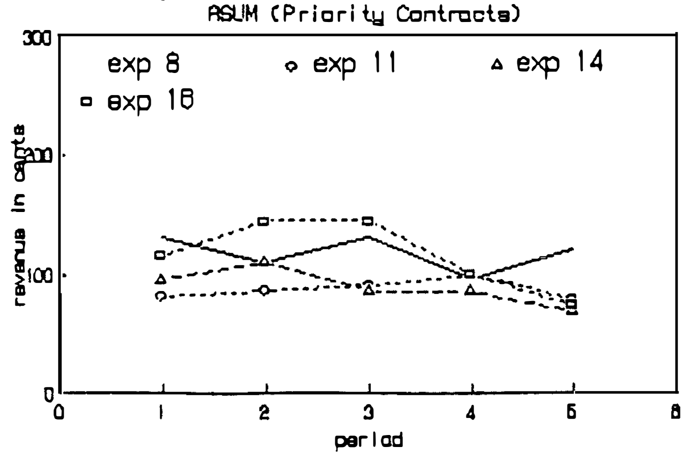


Figure 26 Time Series Revenue Market 2
ASUM (Priority Contracts)

Figure Time Series Total Revenue
IG (Priority Contracts)

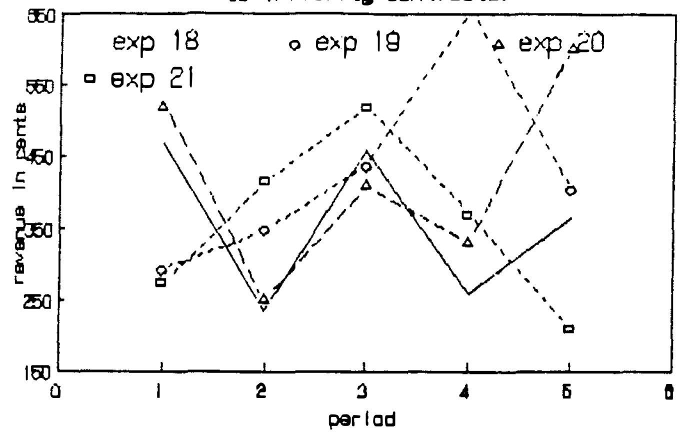


Figure 30 Time Series of Total Revenue
ASUM (Contingent Contracts)

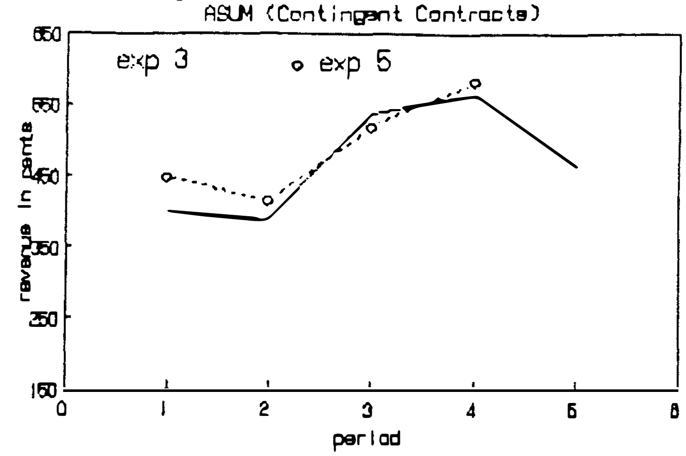


Figure 28 Time Series Revenue Market 1
IG (Priority Contracts)

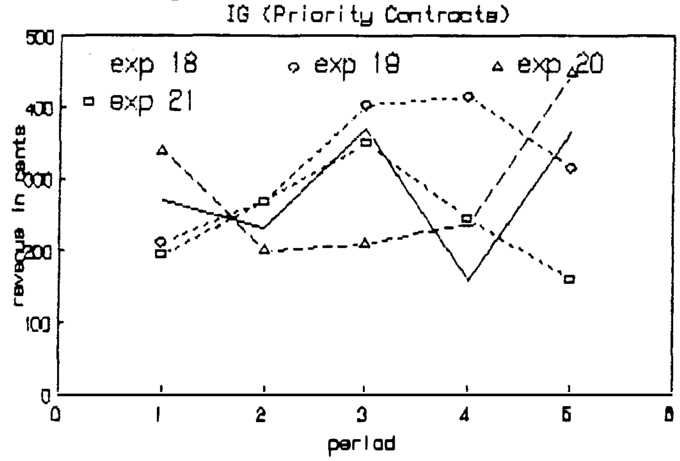


Figure 31 Time Series Revenue Market 1
ASUM (Contingent Contracts)

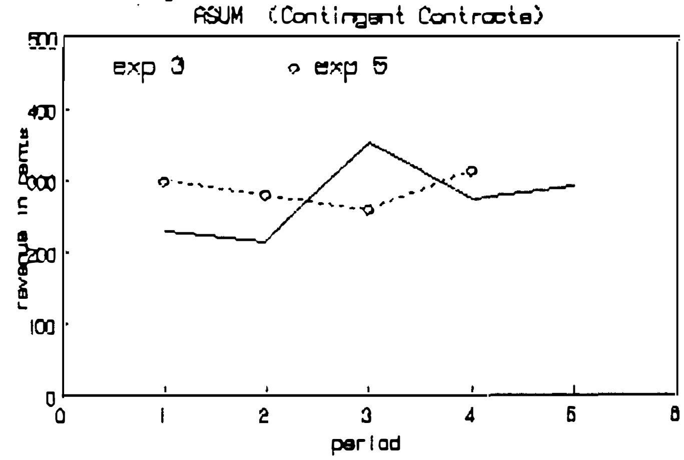


Figure 29 Times Series Revenue Market 2
IG (Priority Contracts)

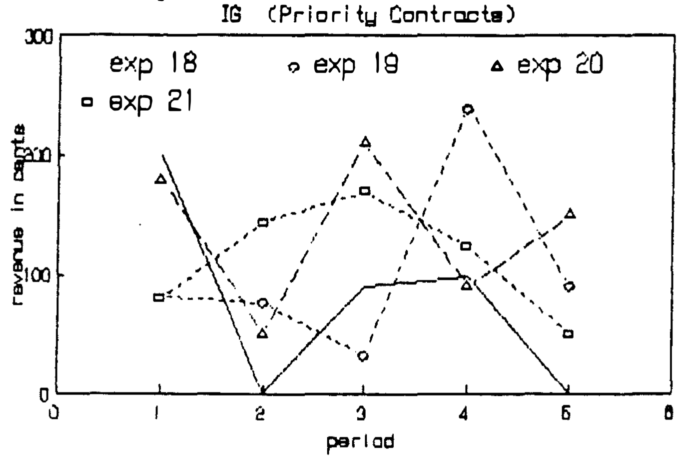


Figure 32 Times Series Revenue Market 2
ASUM (Contingent Contracts)

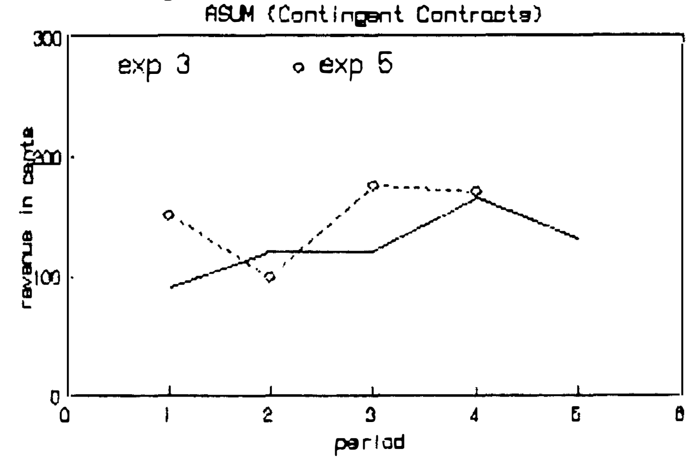
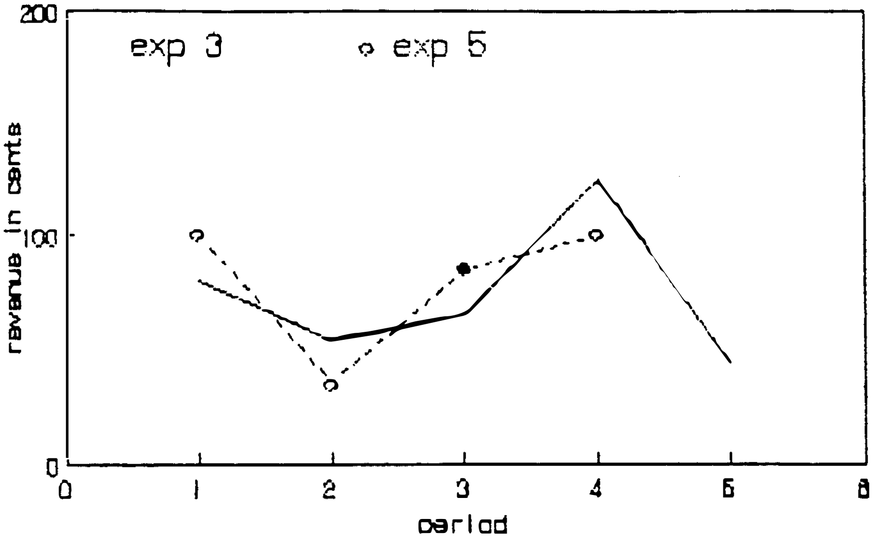


Figure 33 Time Series Revenue Market 3
ASUM (Contingent Contracts)



APPENDIX E
DATA FROM EXPERIMENTS

Experiment 1
Iterative Groves

Trials = 15

Period 1

No trial data for trial 1 (one subject on portable ? clock function and froze screens).
Final Allocations 10/15 trials

-+ trial 10 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	9	10	?	200
	3	5	9	?	70

-+ trial 15 +-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	1	12	9	?	200
	5	6	7	?	0

Period 2

-+ trial 1 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	11	9	100	74
	6	9	7	176	150
OUTS:	sub	x	y	bid	price
	2	12	9	250	276
	3	15	14	100	276
	4	12	9	133	276
	5	12	8	75	276

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	11	9	0	0
	2	12	9	0	0
	3	15	14	0	0
	4	12	9	0	0
	5	12	8	0	0
	6	9	7	0	0

-+ trial 2 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	12	9	300	201
	3	3	6	5	0
	4	5	4	120	70
OUTS:	sub	x	y	bid	price
	1	11	9	100	224
	5	8	10	75	125
	6	9	7	201	300

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	11	9	0	0
	2	12	9	0	0
	3	3	6	0	0
	4	5	4	0	0
	5	8	10	0	0
	6	9	7	0	0

-+ trial 3 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	12	9	250	175
	3	3	6	5	0
	4	5	4	100	0
OUTS:	sub	x	y	bid	price
	1	11	9	0	250
	5	12	10	175	250
	6	12	13	0	255

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	6	12	13	250	100
OUTS:	sub	x	y	bid	price
	1	11	9	100	250
	2	12	9	0	250
	3	3	6	0	0
	4	5	4	0	0
	5	12	10	0	250

-+ trial 4 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	12	9	250	30
	5	8	10	170	30
OUTS:	sub	x	y	bid	price
	1	7	7	0	170
	3	3	6	5	145
	4	5	4	25	165
	6	12	13	0	395

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	1	7	7	10	0
	6	12	13	250	0
OUTS:	sub	x	y	bid	price
	2	12	9	0	250
	3	3	6	0	10
	4	5	4	0	10
	5	8	10	0	250

-+ trial 5 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	12	9	230	166
	5	8	10	160	0
OUTS:	sub	x	y	bid	price
	1	7	7	0	160
	3	9	10	5	230
	4	12	9	166	230
	6	12	13	0	390

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	1	7	7	10	0
	6	12	13	250	0
OUTS:	sub	x	y	bid	price
	2	12	9	0	250
	3	9	10	0	250
	4	12	9	0	250
	5	8	10	0	250

-+ trial 6 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	12	9	250	230
	5	8	10	180	5
OUTS:	sub	x	y	bid	price
	1	7	7	0	180
	3	3	6	5	180
	4	12	9	230	250
	6	12	13	0	425

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	1	7	7	25	0
	6	12	13	276	0
OUTS:	sub	x	y	bid	price
	2	12	9	0	276
	3	3	6	0	25
	4	12	9	0	276
	5	8	10	0	276

Period 3

-+ trial 1 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	5	12	4	150	75
	6	6	12	175	75
OUTS:	sub	x	y	bid	price
	1	6	7	75	150
	2	9	11	100	250
	3	12	13	100	250
	4	9	10	145	250

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	6	7	0	0
	2	9	11	0	0
	3	12	13	0	0
	4	9	10	0	0
	5	12	4	0	0
	6	6	12	0	0

-+ trial 2 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	11	11	500	325
OUTS:	sub	x	y	bid	price
	1	6	10	100	425
	3	7	13	250	425
	4	3	14	135	425
	5	12	4	75	250
	6	6	12	175	425

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	6	10	0	0
	2	11	11	0	0
	3	7	13	0	0
	4	3	14	0	0
	5	12	4	0	0
	6	6	12	0	0

-+ trial 3 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	3	12	13	425	325
OUTS:	sub	x	y	bid	price
	1	9	10	150	250
	2	7	7	0	0
	4	9	6	111	250
	5	5	9	0	250
	6	8	10	175	275

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	7	7	1	0
	5	5	9	20	0
OUTS:	sub	x	y	bid	price
	1	9	10	0	1
	3	12	13	0	20
	4	9	6	0	1
	6	8	10	0	1

-+ trial 4 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	12	13	251	135
	4	3	6	66	0
OUTS:	sub	x	y	bid	price
	2	9	9	0	251
	3	12	13	135	251
	5	12	9	0	251
	6	12	10	0	251

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	6	12	10	201	40
OUTS:	sub	x	y	bid	price
	1	12	13	0	201
	2	9	9	0	201
	3	12	13	0	201
	4	3	6	0	0
	5	12	9	40	201

-+ trial 5 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	3	12	9	258	200
	4	3	6	45	0
OUTS:	sub	x	y	bid	price
	1	12	13	200	258
	2	11	11	175	258
	5	5	9	0	45
	6	12	12	0	258

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	6	12	12	250	40
OUTS:	sub	x	y	bid	price
	1	12	13	0	250
	2	11	11	0	210
	3	12	9	0	210
	4	3	6	0	0
	5	5	9	40	250

-+ trial 6 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	7	11	150	100
OUTS:	sub	x	y	bid	price
	1	6	7	0	0
	3	12	13	100	150
	4	3	10	35	150
	5	5	4	0	0
	6	12	12	0	150

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	6	7	25	20
	6	12	12	250	20
OUTS:	sub	x	y	bid	price
	2	7	11	0	250
	3	12	13	0	250
	4	3	10	0	250
	5	5	4	20	25

-+ trial 7 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	7	11	150	56
	5	12	9	170	150
OUTS:	sub	x	y	bid	price
	1	12	10	100	264
	3	12	9	150	170
	4	3	6	56	150
	6	12	12	0	264

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	6	12	12	251	0
OUTS:	sub	x	y	bid	price
	1	12	10	0	251
	2	7	11	0	251
	3	12	9	0	251
	4	3	6	0	0
	5	12	9	0	251

-+ trial 8 +-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	7	11	150	10
	5	5	9	160	10
OUTS:	sub	x	y	bid	price
	1	6	7	0	150
	3	12	9	10	150
	4	3	6	0	150
	6	12	12	0	310

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	6	7	20	12

	sub	x	y	bid	price
	6	12	12	251	12
OUTS:	sub	x	y	bid	price
	2	7	11	0	251
	3	12	9	0	251
	4	3	6	12	20
	5	5	9	0	251

-* trial 9 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	12	9	151	150
	5	5	9	270	150
OUTS:	sub	x	y	bid	price
	1	6	7	0	151
	2	7	11	150	151
	4	3	6	0	151
	6	12	12	0	421

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	3	6	50	20
	6	12	12	250	20
OUTS:	sub	x	y	bid	price
	1	6	7	20	50
	2	7	11	0	250
	3	12	9	0	250
	5	5	9	0	250

-* trial 10 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	10	201	185
	5	5	9	190	185
OUTS:	sub	x	y	bid	price
	2	7	11	175	201
	3	12	9	151	201
	4	9	10	144	201
	6	8	10	185	190

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	12	10	0	0
	2	7	11	0	0
	3	12	9	0	0
	4	9	10	0	0
	5	5	9	0	0
	6	8	10	0	0

-* trial 11 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	3	6	50	0
	6	8	12	201	50
OUTS:	sub	x	y	bid	price
	2	11	11	25	201
	3	12	13	50	201

-* trial 12 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	7	9	50	33
	6	8	8	125	33
OUTS:	sub	x	y	bid	price
	2	11	11	1	50
	4	3	6	33	50

-* trial 13 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	3	6	66	50
	6	8	8	125	50
OUTS:	sub	x	y	bid	price
	2	11	11	1	66
	3	7	9	50	66

-* trial 14 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	7	3	100	70
	6	8	8	100	70
OUTS:	sub	x	y	bid	price
	2	7	7	0	100
	4	9	10	70	100

-* trial 15 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	7	3	100	45
	6	8	12	251	45
OUTS:	sub	x	y	bid	price
	2	11	11	1	251
*	4	3	6	45	100

Period 4

-* trial 1 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	12	13	300	225
OUTS:	sub	x	y	bid	price
	1	12	12	200	300
	3	11	11	100	300
	4	12	9	225	300
	5	9	10	110	300
	6	12	4	200	300

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	12	12	0	0
	2	12	13	0	0
	3	11	11	0	0
	4	12	9	0	0
	5	9	10	0	0
	6	12	4	0	0

-* trial 2 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	7	11	100	100
	6	12	4	250	222
OUTS:	sub	x	y	bid	price
	1	8	8	100	100
	2	12	13	300	350
	4	12	9	222	250
	5	3	6	0	50

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	5	3	6	40	0
OUTS:	sub	x	y	bid	price
	1	8	8	0	0
	2	12	13	0	0
	3	7	11	0	0
	4	12	9	0	0
	6	12	4	0	0

-* trial 3 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	4	7	9	150	105
	6	12	9	250	150
OUTS:	sub	x	y	bid	price
	1	8	8	105	150
	2	12	13	300	400
	3	7	11	100	150
	5	15	14	0	400

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	5	15	14	60	0
OUTS:	sub	x	y	bid	price
	1	8	8	0	60

2	12	13	0	60
3	7	11	0	60
4	7	9	0	60
6	12	9	0	60

-* trial 4 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	4	7	9	135	75
	6	12	9	250	190
OUTS:	sub	x	y	bid	price
	1	12	10	175	250
	2	12	13	325	385
	3	11	11	150	250
	5	15	14	0	385

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	15	14	100	0
OUTS:	sub	x	y	bid	price
	1	12	10	0	100
	2	12	13	0	100
	3	11	11	0	100
	4	7	9	0	100
	6	12	9	0	100

-* trial 5 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	6	7	170	165
	6	12	9	250	200
OUTS:	sub	x	y	bid	price
	1	6	8	0	170
	3	11	11	200	250
	4	7	9	165	170
	5	15	14	0	420

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	15	14	150	25
OUTS:	sub	x	y	bid	price
	1	6	8	25	150
	2	6	7	0	125
	3	11	11	0	125
	4	7	9	0	125
	6	12	9	0	125

-* trial 6 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	5	9	14	405	325
	6	5	4	151	80
OUTS:	sub	x	y	bid	price
	1	12	12	0	405
	2	12	13	325	405
	3	11	7	149	405
	4	7	3	80	151

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	1	12	12	175	0
OUTS:	sub	x	y	bid	price
	2	12	13	0	175
	3	11	7	0	175
	4	7	3	0	0
	5	9	14	0	175
	6	5	4	0	0

-* trial 7 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	12	13	808	200
	6	5	4	151	0
OUTS:	sub	x	y	bid	price
	1	12	12	0	808
	3	9	9	99	808
	4	12	13	200	808
	5	3	6	0	151

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	1	12	12	200	0
	5	3	6	100	0
OUTS:	sub	x	y	bid	price
	2	12	13	0	200
	3	9	9	0	200
	4	12	13	0	200
	6	5	4	0	100

-* trial 8 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	12	13	325	100
	6	5	4	151	100
OUTS:	sub	x	y	bid	price
	1	12	12	0	325
	3	7	7	0	151
	4	7	3	100	151
	5	15	6	0	325

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	15	6	500	150
OUTS:	sub	x	y	bid	price
	1	12	12	150	500
	2	12	13	0	500
	3	7	7	0	350
	4	7	3	0	350
	6	5	4	0	0

-* trial 9 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	6	13	240	35
	4	7	3	170	0
	6	5	4	165	0
OUTS:	sub	x	y	bid	price
	1	6	8	30	240
	3	11	11	200	405
	5	9	10	0	405

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	9	10	151	0
OUTS:	sub	x	y	bid	price
	1	6	8	0	0
	2	12	13	0	151
	3	11	11	0	151
	4	7	3	0	0
	6	5	4	0	0

-* trial 10 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	6	13	240	160
	4	7	3	170	0
	6	5	4	16	0
OUTS:	sub	x	y	bid	price
	1	8	10	160	240
	3	7	7	74	335

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	9	10	100	0
OUTS:	sub	x	y	bid	price
	1	8	10	0	0
	2	6	13	0	100
	3	7	7	0	0
	4	7	3	0	0
	6	5	4	0	0

-* trial 11 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:					
	1	9	10	151	90
	5	8	10	100	90
OUTS:	sub	x	y	bid	price
	3	7	7	90	100

-* trial 12 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:					
	1	9	10	70	50
	6	8	10	65	50
OUTS:	sub	x	y	bid	price
	3	9	9	50	65

-* trial 13 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:					
	1	9	10	55	45
	5	8	10	65	55
OUTS:	sub	x	y	bid	price
	3	11	11	0	110

Period 5

-* trial 1 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:					
	1	5	4	100	0
	3	12	13	300	300
OUTS:	sub	x	y	bid	price
	2	12	12	300	300
	4	9	11	111	300
	5	12	13	0	300
	6	9	6	0	289

MARKET 2 allocations:

	sub	x	y	bid	price
INS:					
	5	12	13	50	25
OUTS:	sub	x	y	bid	price
	1	5	4	0	0
	2	12	12	0	50
	3	12	13	0	50
	4	9	11	0	25
	6	9	6	25	50

-* trial 2 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:					
	2	12	12	300	200
	6	3	6	100	75
OUTS:	sub	x	y	bid	price
	1	5	4	75	100
	3	12	13	200	300
	4	7	7	33	100
	5	12	13	0	300

MARKET 2 allocations:

	sub	x	y	bid	price
INS:					
	5	12	13	200	0
OUTS:	sub	x	y	bid	price
	1	5	4	0	0
	2	12	12	0	200
	3	12	13	0	200
	4	7	7	0	0
	6	3	6	0	0

-* trial 3 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:					
	3	12	13	301	300
	6	3	6	101	44
OUTS:	sub	x	y	bid	price
	1	5	4	0	101
	2	12	12	300	301
	4	7	7	44	101
	5	12	13	0	301

MARKET 2 allocations:

	sub	x	y	bid	price
INS:					
	1	5	4	100	0
	5	12	13	5000	0
OUTS:	sub	x	y	bid	price
	2	12	12	0	5000
	3	12	13	0	5000
	4	7	7	0	100
	6	3	6	0	100

-* trial 4 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:					
	3	12	13	301	300
	6	3	6	101	66
OUTS:	sub	x	y	bid	price
	1	5	4	0	101
	2	12	12	300	301
	4	7	7	66	101
	5	12	13	0	301

MARKET 2 allocations:

	sub	x	y	bid	price
INS:					
	1	5	4	100	0
	5	12	13	5000	0
OUTS:	sub	x	y	bid	price
	2	12	12	0	5000
	3	12	13	0	5000
	4	7	7	0	100
	6	3	6	0	100

-* trial 5 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:					
	3	12	13	301	300
	6	3	6	101	66
OUTS:	sub	x	y	bid	price
	1	5	4	0	101
	2	12	12	300	301
	4	7	7	66	101
	5	12	13	0	301

MARKET 2 allocations:

	sub	x	y	bid	price
INS:					
	1	5	4	100	0
	5	12	13	5000	0
OUTS:	sub	x	y	bid	price
	2	12	12	0	5000
	3	12	13	0	5000
	4	7	7	0	100
	6	3	6	0	100

Experiment 2
Iterative Groves

Period 1

-* trial 1 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	15	6	100	10
	3	5	4	91	10
OUTS:	sub	x	y	bid	price
	1	4	3	10	91
	4	8	10	0	90
	5	12	13	0	100
	6	9	9	0	90

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	5	12	13	200	31
OUTS:	sub	x	y	bid	price
	1	4	3	0	0
	2	15	6	0	200
	3	5	4	0	0
	4	8	10	0	169
	6	9	9	31	200

-* trial 2 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	5	4	93	0
	5	12	13	200	150
OUTS:	sub	x	y	bid	price
	1	12	13	0	200
	2	15	6	130	200
	4	12	12	150	200
	6	7	7	0	93

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	13	20	0
	6	7	7	31	0
OUTS:	sub	x	y	bid	price
	2	15	6	0	51
	3	5	4	0	20
	4	12	12	0	20
	5	12	13	0	20

-* trial 3 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	5	4	97	0
	5	9	10	500	250
OUTS:	sub	x	y	bid	price
	1	12	13	0	500
	2	15	6	250	500
	4	8	10	0	97
	6	11	11	111	500

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	8	10	76	20
OUTS:	sub	x	y	bid	price
	1	12	13	20	76
	2	15	6	0	76
	3	5	4	0	0
	5	9	10	0	0
	6	11	11	0	76

-* trial 4 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	15	6	750	250
	3	5	4	103	0
OUTS:	sub	x	y	bid	price
	1	12	9	0	750
	4	8	10	0	603
	5	9	7	250	750
	6	11	9	0	603

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	8	10	76	0
	6	11	9	41	15
OUTS:	sub	x	y	bid	price
	1	12	9	15	41
	2	15	6	0	117
	3	5	4	0	41
	5	9	7	0	41

-* trial 5 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	5	4	100	0
	5	12	13	2000	250
OUTS:	sub	x	y	bid	price
	1	12	9	0	2000
	2	15	14	250	2000
	4	8	10	0	2000
	6	11	9	0	2000

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	9	42	26
	4	8	10	76	0
OUTS:	sub	x	y	bid	price
	2	15	14	0	118
	3	5	4	0	42
	5	12	13	0	118
	6	11	9	26	42

-* trial 6 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	15	14	2100	1500
	3	5	4	100	0
OUTS:	sub	x	y	bid	price
	1	12	9	0	2100
	4	8	10	0	700
	5	9	10	1500	2100
	6	9	11	0	2100

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	9	42	0
	4	8	10	76	0
OUTS:	sub	x	y	bid	price
	2	15	14	0	118
	3	5	4	0	42
	5	9	10	0	42
	6	9	11	41	118

-* trial 7 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	5	4	100	0
	5	9	10	2500	0
OUTS:	sub	x	y	bid	price
	1	12	9	0	2500
	2	9	10	0	100
	4	8	10	0	100
	6	11	9	0	100

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	9	10	200	76
	6	11	9	100	76
OUTS:	sub	x	y	bid	price
	1	12	9	10	224
	3	5	4	0	100
	4	8	10	76	100
	5	9	10	0	100

-* trial 8 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	5	9	10	3000	105
	6	11	9	111	105
OUTS:	sub	x	y	bid	price
	1	7	9	0	111
	2	9	10	0	111
	3	5	4	100	111
	4	8	10	105	111

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	7	9	30	0
	2	9	10	200	0
OUTS:	sub	x	y	bid	price
	3	5	4	0	30
	4	8	10	0	30
	5	9	10	0	30
	6	11	9	0	30

-* trial 9 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	5	4	160	106
	5	9	10	3500	106
OUTS:	sub	x	y	bid	price
	1	7	9	0	160
	2	9	10	0	160
	4	8	10	0	160
	6	11	9	106	160

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	9	10	200	20
	4	8	10	53	20
OUTS:	sub	x	y	bid	price
	1	7	9	20	53
	3	5	4	0	53
	5	9	10	0	53
	6	11	9	0	53

-* trial 10 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	4	3	50	0
	3	5	4	180	81
	5	9	10	9999	131
OUTS:	sub	x	y	bid	price
	2	15	6	160	10049
	4	8	10	0	230
	6	11	9	131	230

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	8	10	53	0
OUTS:	sub	x	y	bid	price

	1	4	3	0	0
	2	15	6	0	53
	3	5	4	0	0
	5	9	10	0	0
	6	11	9	0	0

-* trial 11 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	9	10	100	0
	4	8	10	76	0
OUTS:	sub	x	y	bid	price
	6	9	11	46	176

-* trial 12 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	11	11	300	196
OUTS:	sub	x	y	bid	price
	2	9	10	120	224
	4	8	10	76	180

-* trial 13 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	9	10	280	46
	4	6	8	51	0
OUTS:	sub	x	y	bid	price
	6	9	11	46	280

-* trial 14 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	9	10	76	0
	6	11	9	46	0
OUTS:	sub	x	y	bid	price
	2	15	14	2	122

-* trial 15 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	9	10	500	41
	4	9	10	76	41
OUTS:	sub	x	y	bid	price
	6	11	9	41	76

Period 2

-* trial 1 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	5	12	12	1000	200
	6	6	7	121	0
OUTS:	sub	x	y	bid	price
	1	11	11	0	1000
	2	12	13	200	1000
	3	9	10	93	1000
	4	5	9	30	1000

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	11	11	50	0
OUTS:	sub	x	y	bid	price
	2	12	13	0	50
	3	9	10	0	50
	4	5	9	0	0
	5	12	12	0	50
	6	6	7	0	0

-* trial 2 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	9	10	500	500
	6	6	7	121	0
OUTS:	sub	x	y	bid	price
	1	11	11	0	500
	2	12	9	500	500
	4	5	9	0	121
	5	12	12	400	500

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	11	11	50	0
	4	5	9	20	0
OUTS:	sub	x	y	bid	price
	2	12	9	0	50
	3	9	10	0	50
	5	12	12	0	70
	6	6	7	0	20

-* trial 3 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	5	12	12	1500	550
	6	6	7	71	0
OUTS:	sub	x	y	bid	price
	1	11	11	0	1500
	2	12	9	550	1500
	3	15	6	100	1571
	4	5	9	0	1021

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	11	11	50	0
	4	5	9	10	0
OUTS:	sub	x	y	bid	price
	2	12	9	0	50
	3	15	6	0	50
	5	12	12	0	60
	6	6	7	0	10

-* trial 4 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	9	10	9999	3000
	6	6	7	61	0
OUTS:	sub	x	y	bid	price
	1	11	11	0	9999
	2	12	9	0	9999
	4	5	9	0	61
	5	12	12	3000	9999

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	12	9	300	50
	4	5	9	10	0
OUTS:	sub	x	y	bid	price
	1	11	11	50	300
	3	9	10	0	300
	5	12	12	0	310
	6	6	7	0	10

-* trial 5 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	9	10	100	51
	5	6	8	9999	51
OUTS:	sub	x	y	bid	price
	1	11	11	0	100
	2	12	9	0	100
	4	5	9	0	100
	6	6	7	51	100

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	12	9	150	50
	4	5	9	10	0
OUTS:	sub	x	y	bid	price
	1	11	11	50	150
	3	9	10	0	150
	5	6	8	0	10
	6	6	7	0	10

-* trial 6 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	5	8	12	9999	150
OUTS:	sub	x	y	bid	price
	1	11	11	0	9999
	2	12	9	150	9999
	3	9	10	101	9999
	4	5	9	0	9849
	6	12	10	0	9999

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	11	11	300	50
	4	5	9	10	0
OUTS:	sub	x	y	bid	price
	2	12	9	0	300
	3	9	10	0	300
	5	8	12	0	310
	6	12	10	50	300

-* trial 7 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	12	9	200	121
	5	8	8	9999	0
OUTS:	sub	x	y	bid	price
	1	11	11	0	200
	3	9	6	85	200
	4	5	9	0	200
	6	12	7	121	200

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	11	11	250	0
	4	5	9	10	0
OUTS:	sub	x	y	bid	price
	2	12	9	0	250
	3	9	6	0	10
	5	8	8	0	10
	6	12	7	0	250

-* trial 8 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	12	9	300	0
	5	8	10	9999	0
OUTS:	sub	x	y	bid	price
	1	11	11	0	10299
	3	9	6	0	300
	4	5	9	0	300
	6	12	10	0	300

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	11	11	250	51
	3	9	6	20	10
OUTS:	sub	x	y	bid	price
	2	12	9	0	260
	4	5	9	10	20
	5	8	10	0	209
	6	12	10	61	260

-* trial 9 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	12	9	500	141
	5	8	8	9999	0
OUTS:	sub	x	y	bid	price
	1	11	11	0	500
	3	9	6	0	500
	4	5	9	0	500
	6	12	7	141	500

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	11	11	250	12
	4	5	9	20	12
OUTS:	sub	x	y	bid	price
	2	12	9	0	250
	3	9	6	12	20
	5	8	8	0	20
	6	12	7	0	250

-* trial 10 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	12	9	500	171
	5	8	8	9999	100
OUTS:	sub	x	y	bid	price
	1	7	7	100	495
	3	9	6	120	495
	4	3	2	5	380
	6	12	7	171	500

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	7	7	0	0
	2	12	9	0	0
	3	9	6	0	0
	4	3	2	0	0
	5	8	8	0	0
	6	12	7	0	0

-* trial 11 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	11	11	450	71
	4	5	9	13	0
OUTS:	sub	x	y	bid	price
	3	15	14	50	463
	6	9	10	71	450

-* trial 12 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	11	11	450	76
	3	9	6	40	12
OUTS:	sub	x	y	bid	price
	4	5	9	12	40
	6	9	10	76	450

-* trial 13 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	11	11	450	66
	3	9	6	55	25
OUTS:	sub	x	y	bid	price
	4	5	9	25	55
	6	9	10	66	450

-* trial 14 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	11	11	425	66
	3	9	6	57	10
OUTS:	sub	x	y	bid	price
	4	3	2	10	57
	6	9	10	66	425

Period 3

-* trial 1 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	5	5	4	5	0
	6	12	10	191	150
OUTS:	sub	x	y	bid	price
	1	12	13	0	191
	2	11	11	100	191
	3	12	13	150	191
	4	9	10	23	191

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	12	13	500	0
OUTS:	sub	x	y	bid	price
	2	11	11	0	600
	3	12	13	0	600
	4	9	10	0	600
	5	5	4	0	0
	6	12	10	0	600

-* trial 2 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	3	12	9	280	245
	4	3	6	30	0
	5	5	4	5	0
OUTS:	sub	x	y	bid	price
	1	12	13	0	285
	2	11	11	250	285
	6	12	10	181	280

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	12	13	600	0
OUTS:	sub	x	y	bid	price
	2	11	11	0	600
	3	12	9	0	600
	4	3	6	0	0
	5	5	4	0	0
	6	12	10	0	600

-* trial 3 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	3	12	9	280	5
	6	6	8	88	0
OUTS:	sub	x	y	bid	price
	1	12	13	0	368
	2	7	11	0	88
	4	3	6	0	88
	5	12	9	5	290

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	7	11	600	600
	4	3	6	20	0
OUTS:	sub	x	y	bid	price
	1	12	13	600	600
	3	12	9	0	20
	5	12	9	0	20
	6	6	9	0	20

-* trial 4 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	3	12	9	280	100
	6	6	8	101	100
OUTS:	sub	x	y	bid	price
	1	12	13	0	376
	2	7	11	100	101
	4	3	6	0	96
	5	5	4	5	101

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	12	13	600	0
	4	3	6	15	0
OUTS:	sub	x	y	bid	price
	2	7	11	0	600
	3	12	9	0	600
	5	5	4	0	15
	6	6	8	0	600

-* trial 5 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	2	7	11	115	71
	3	12	9	290	71
OUTS:	sub	x	y	bid	price
	1	12	13	0	390
	4	3	6	0	110
	5	5	4	5	115
	6	6	8	71	115

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	1	12	13	600	0
	4	3	6	15	0
OUTS:	sub	x	y	bid	price
	2	7	11	0	600
	3	12	9	0	600
	5	5	4	0	15
	6	6	8	0	600

-* trial 6 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	sub	x	y	bid	price
	3	12	9	280	125
	5	5	4	150	125
OUTS:	sub	x	y	bid	price
	1	12	13	0	280
	2	7	11	125	150
	4	3	6	0	0
	6	9	8	71	150

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	13	600	0
	4	3	6	10	0
OUTS:	sub	x	y	bid	price
	2	7	11	0	600
	3	12	9	0	600
	5	5	4	0	10
	6	8	8	0	600

-* trial 7 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	7	11	180	125
	3	12	9	215	200
OUTS:	sub	x	y	bid	price
	1	12	13	0	395
	4	3	6	0	180
	5	12	4	200	215
	6	8	8	125	180

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	13	600	0
	4	3	6	10	0
OUTS:	sub	x	y	bid	price
	2	7	11	0	600
	3	12	9	0	600
	5	12	4	0	600
	6	8	8	0	600

-* trial 8 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	7	11	150	0
	5	12	9	400	200
OUTS:	sub	x	y	bid	price
	1	12	13	0	550
	3	12	3	200	400
	4	3	6	0	150
	6	12	12	0	550

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	13	600	100
	4	3	6	10	0
OUTS:	sub	x	y	bid	price
	2	7	11	0	600
	3	12	3	0	600
	5	12	9	0	600
	6	12	12	100	600

-* trial 9 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	7	600	275
	2	7	11	180	121
OUTS:	sub	x	y	bid	price
	3	12	9	275	600
	4	3	6	0	175
	5	5	4	5	180
	6	8	8	121	180

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	3	6	10	0
OUTS:	sub	x	y	bid	price
	1	12	7	0	0
	2	7	11	0	0
	3	12	9	0	0
	5	5	4	0	0
	6	8	8	0	0

-* trial 10 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	7	400	280
	5	5	4	9999	125
OUTS:	sub	x	y	bid	price
	2	9	11	170	400
	3	12	9	280	400
	4	15	14	0	400
	6	8	8	125	400

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	15	14	10	0
OUTS:	sub	x	y	bid	price
	1	12	7	0	10
	2	9	11	0	10
	3	12	9	0	10
	5	5	4	0	0
	6	8	8	0	10

-* trial 11 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	12	9	108	101
OUTS:	sub	x	y	bid	price
	2	9	11	100	108
	4	15	14	10	109
	6	12	12	101	108

-* trial 12 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	9	11	120	116
OUTS:	sub	x	y	bid	price
	3	12	9	115	120
	4	9	10	20	120
	6	12	12	116	120

-* trial 13 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	9	11	150	125
	6	6	8	11	0
OUTS:	sub	x	y	bid	price
	3	12	9	125	150
	4	9	10	40	150

-* trial 14 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	12	9	160	150
	6	6	8	31	25
OUTS:	sub	x	y	bid	price
	2	9	11	150	160
	4	3	6	25	31

-* trial 15 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	12	9	110	33
	6	6	8	33	0
OUTS:	sub	x	y	bid	price
	2	9	11	0	110
	4	9	10	33	110

Period 4

-* trial 1 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	5	9	10	200	100
	6	5	4	133	45
OUTS:	sub	x	y	bid	price
	1	12	12	0	200
	2	12	13	100	200
	3	11	11	10	200
	4	7	9	45	133

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	12	600	0
OUTS:	sub	x	y	bid	price
	2	12	13	0	600
	3	11	11	0	600
	4	7	9	0	600
	5	9	10	0	600
	6	5	4	0	0

-* trial 2 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	9	10	200	175
	6	5	4	133	10
OUTS:	sub	x	y	bid	price
	1	12	12	0	200
	3	7	11	175	200
	4	12	13	120	200
	5	9	10	10	133

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	12	600	0
OUTS:	sub	x	y	bid	price
	2	9	10	0	600
	3	7	11	0	600
	4	12	13	0	600
	5	9	10	0	600
	6	5	4	0	0

-* trial 3 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	12	600	200
	6	5	4	133	0
OUTS:	sub	x	y	bid	price
	2	9	10	200	600
	3	9	9	100	533
	4	7	9	100	533
	5	9	10	1	533

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	12	12	0	0
	2	9	10	0	0
	3	9	9	0	0
	4	7	9	0	0
	5	9	10	0	0
	6	5	4	0	0

-* trial 4 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	9	9	9999	600
	6	5	4	133	125
OUTS:	sub	x	y	bid	price
	1	12	12	600	9999
	2	12	13	500	9999
	4	7	9	125	133
	5	9	10	1	133

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	12	12	0	0
	2	12	13	0	0
	3	9	9	0	0
	4	7	9	0	0
	5	9	10	0	0
	6	5	4	0	0

-* trial 5 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	12	13	1000	600
	6	5	4	133	0
OUTS:	sub	x	y	bid	price
	1	8	10	600	1000
	3	9	11	98	1000
	4	7	9	0	533
	5	9	10	1	533

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	7	9	1	0
OUTS:	sub	x	y	bid	price
	1	8	10	0	0
	2	12	13	0	1
	3	9	11	0	0
	5	9	10	0	0
	6	5	4	0	0

-* trial 6 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	12	1005	200
	6	5	4	133	0
OUTS:	sub	x	y	bid	price
	2	12	13	200	1005
	3	9	9	99	1005
	4	7	9	0	1005
	5	9	10	1	1005

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	7	9	1	0
OUTS:	sub	x	y	bid	price
	1	12	12	0	1
	2	12	13	0	1
	3	9	9	0	0
	5	9	10	0	0
	6	5	4	0	0

-* trial 7 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	12	1500	200
	6	5	4	133	0
OUTS:	sub	x	y	bid	price
	2	12	13	200	1500
	3	9	9	100	1500
	4	7	9	0	1500
	5	9	10	1	1500

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	7	9	1	0
OUTS:	sub	x	y	bid	price
	1	12	12	0	1
	2	12	13	0	1
	3	9	9	0	0
	5	9	10	0	0
	6	5	4	0	0

-* trial 8 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	12	1300	1000
	5	3	6	9999	166
OUTS:	sub	x	y	bid	price
	2	12	13	1000	1300
	3	7	9	120	1134
	4	7	9	0	1134
	6	5	4	166	1180

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	7	9	1	0
OUTS:	sub	x	y	bid	price
	1	12	12	0	1
	2	12	13	0	1
	3	7	9	0	0
	5	3	6	0	0
	6	5	4	0	0

-* trial 9 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	7	9	9999	1000
	6	5	4	166	1
OUTS:	sub	x	y	bid	price
	1	12	12	1000	9999
	2	12	13	1000	9999
	4	12	13	0	9999
	5	9	10	1	166

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	12	13	1	0
OUTS:	sub	x	y	bid	price
	1	12	12	0	1
	2	12	13	0	1
	3	7	9	0	1
	5	9	10	0	1
	6	5	4	0	0

-* trial 10 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	12	13	800	300
	5	3	6	1000	166
OUTS:	sub	x	y	bid	price
	1	12	12	300	800
	3	7	9	125	634
	4	7	3	75	634
	6	5	4	166	675

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	12	12	0	0
	2	12	13	0	0
	3	7	9	0	0
	4	7	3	0	0
	5	3	6	0	0
	6	5	4	0	0

-* trial 11 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	12	600	120
	6	5	4	56	0
OUTS:	sub	x	y	bid	price
	3	7	9	50	600
	4	12	13	120	600

-* trial 12 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	12	600	149
	6	5	4	21	0
OUTS:	sub	x	y	bid	price
	3	7	9	50	501
	4	7	9	120	571

-* trial 13 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	12	600	195
	6	5	4	66	45
OUTS:	sub	x	y	bid	price
	3	7	9	150	555
	4	4	3	45	66

Period 5

-* trial 1 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	3	2	1	0
	3	12	10	250	100
	6	3	6	101	49
OUTS:	sub	x	y	bid	price
	2	12	12	100	250
	4	9	9	90	250
	5	7	9	50	102

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	3	2	0	0
	2	12	12	0	0
	3	12	10	0	0
	4	9	9	0	0
	5	7	9	0	0
	6	3	6	0	0

-* trial 2 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	3	2	1	0
	2	8	12	200	150
	6	3	6	78	39
OUTS:	sub	x	y	bid	price
	3	12	10	150	200
	4	7	7	40	79
	5	7	9	0	129

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	3	2	0	0
	2	8	12	0	0
	3	12	10	0	0
	4	7	7	0	0
	5	7	9	0	0
	6	3	6	0	0

-* trial 3 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	8	12	250	82
	3	12	7	200	82
OUTS:	sub	x	y	bid	price
	1	3	2	1	119
	4	7	7	40	200
	5	7	9	1	250
	6	3	6	81	199

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	3	2	0	0
	2	8	12	0	0
	3	12	7	0	0
	4	7	7	0	0
	5	7	9	0	0
	6	3	6	0	0

-* trial 4 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	8	12	250	70
	6	3	6	101	30
OUTS:	sub	x	y	bid	price
	1	5	4	20	101
	3	6	7	50	101
	4	11	11	0	250
	5	7	9	0	230

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	11	11	1	0
OUTS:	sub	x	y	bid	price
	1	5	4	0	0
	2	8	12	0	1
	3	6	7	0	0
	5	7	9	0	0
	6	3	6	0	0

-* trial 5 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	9	500	279
	6	3	6	101	0
OUTS:	sub	x	y	bid	price
	2	8	12	250	471
	3	12	7	130	351
	4	11	11	0	500
	5	12	13	4	500

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	11	11	1	0
OUTS:	sub	x	y	bid	price
	1	12	9	0	1
	2	8	12	0	1
	3	12	7	0	1
	5	12	13	0	1
	6	3	6	0	0

-* trial 6 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	5	12	13	500	300
	6	3	6	101	0
OUTS:	sub	x	y	bid	price
	1	12	9	250	451
	2	8	12	300	500
	3	6	10	150	351
	4	11	11	0	500

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	11	11	1	0
OUTS:	sub	x	y	bid	price
	1	12	9	0	1
	2	8	12	0	1
	3	6	10	0	1
	5	12	13	0	1
	6	3	6	0	0

-* trial 7 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	8	12	500	250
	6	3	6	101	0
OUTS:	sub	x	y	bid	price
	1	5	9	0	351
	3	12	10	250	500
	4	11	11	0	500
	5	12	13	3	500

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	5	9	20	0
	4	11	11	1	0
OUTS:	sub	x	y	bid	price
	2	8	12	0	21
	3	12	10	0	1
	5	12	13	0	21
	6	3	6	0	1

-* trial 8 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	12	7	220	199
	5	4	3	250	199
	6	3	6	51	30
OUTS:	sub	x	y	bid	price
	1	5	9	0	220
	2	8	12	250	271
	4	11	11	0	220

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	5	9	20	0
	4	11	11	1	0
OUTS:	sub	x	y	bid	price
	2	8	12	0	21
	3	12	7	0	1
	5	4	3	0	1
	6	3	6	0	1

-* trial 9 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	8	12	300	220
	6	3	6	71	0
OUTS:	sub	x	y	bid	price
	1	5	9	0	151
	3	9	10	220	300
	4	11	11	0	300
	5	12	13	3	300

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	5	9	20	0
	4	11	11	1	0
OUTS:	sub	x	y	bid	price
	2	8	12	0	21
	3	9	10	0	1
	5	12	13	0	21
	6	3	6	0	1

-* trial 10 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	8	12	500	195
	3	12	7	205	121
OUTS:	sub	x	y	bid	price
	1	5	2	20	104
	4	7	7	50	205
	5	12	13	299	604
	6	3	6	101	185

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	5	2	0	0
	2	8	12	0	0
	3	12	7	0	0
	4	7	7	0	0
	5	12	13	0	0
	6	3	6	0	0

-* trial 11 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	9	9	80	60
	6	3	6	41	20
OUTS:	sub	x	y	bid	price
	1	5	9	20	41
	5	12	13	60	80

-* trial 12 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	3	2	1	0
	6	15	14	83	80
OUTS:	sub	x	y	bid	price
	4	9	9	80	83
	5	12	13	80	83

-* trial 13 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	9	9	83	47
	6	9	10	63	27
OUTS:	sub	x	y	bid	price
	1	3	2	20	56
	5	12	13	90	126

-* trial 14 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	3	2	30	12
	5	12	13	126	108
OUTS:	sub	x	y	bid	price
	4	9	9	75	93
	6	9	10	63	81

-* trial 15 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	5	12	13	9999	70
	6	3	6	41	20
OUTS:	sub	x	y	bid	price
	1	3	2	20	41
	4	9	9	50	9979

Experiment 3
Iterative Groves

Period 1

-* trial 1 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	9	125	111
	3	12	9	150	136
OUTS:	sub	x	y	bid	price
	2	9	6	70	150
	4	12	12	100	275
	5	12	13	261	275
	6	9	9	3	150

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	7	9	0	0
	2	9	6	0	0
	3	12	9	0	0
	4	12	12	0	0
	5	12	13	0	0
	6	9	9	0	0

-* trial 2 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	9	125	50
	3	12	9	250	240
OUTS:	sub	x	y	bid	price
	2	9	10	150	250
	4	12	12	300	375
	5	12	10	240	250
	6	9	9	1	225

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	7	9	0	0
	2	9	10	0	0
	3	12	9	0	0
	4	12	12	0	0
	5	12	10	0	0
	6	9	9	0	0

-* trial 3 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	9	125	0
	3	12	9	150	100
OUTS:	sub	x	y	bid	price
	2	9	10	0	150
	4	8	12	0	275
	5	12	13	0	275
	6	11	11	100	150

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	9	10	155	100
OUTS:	sub	x	y	bid	price
	1	7	9	0	0
	3	12	9	0	155
	4	8	12	10	155
	5	12	13	100	155
	6	11	11	0	155

-* trial 4 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	4	8	12	400	400
OUTS:	sub	x	y	bid	price
	1	7	9	125	150
	2	3	10	150	150
	3	12	9	250	250
	5	9	10	0	250
	6	11	11	0	275

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	9	10	90	0
OUTS:	sub	x	y	bid	price
	1	7	9	0	0
	2	3	10	0	0
	3	12	9	0	90
	4	8	12	0	90
	6	11	11	0	90

-* trial 5 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	9	150	10
	3	12	4	250	220
OUTS:	sub	x	y	bid	price
	2	3	6	10	150
	4	12	12	100	390
	5	12	7	220	250
	6	11	11	1	250

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	7	9	0	0
	2	3	6	0	0
	3	12	4	0	0
	4	12	12	0	0
	5	12	7	0	0
	6	11	11	0	0

-* trial 6 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	3	5	4	250	150
	5	12	7	280	160
OUTS:	sub	x	y	bid	price
	1	7	9	150	250
	2	9	10	160	280
	4	12	12	0	280
	6	7	9	100	250

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	4	12	12	75	0
OUTS:	sub	x	y	bid	price
	1	7	9	0	75
	2	9	10	0	75
	3	5	4	0	0
	5	12	7	0	75
	6	7	9	0	75

-* trial 7 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	3	6	100	0
	3	5	4	300	100
	5	12	7	260	200
OUTS:	sub	x	y	bid	price
	1	7	9	200	260
	4	12	12	0	360
	6	11	11	0	360

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	4	12	12	80	0
OUTS:	sub	x	y	bid	price
	1	7	9	0	80
	2	3	6	0	0
	3	5	4	0	0
	5	12	7	0	80
	6	11	11	0	80

-* trial 8 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	12	9	300	260
	2	3	6	100	0
	3	5	4	300	160
OUTS:	sub	x	y	bid	price
	4	12	12	89	400
	5	12	7	260	300
	6	11	11	10	400

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	12	9	0	0
	2	3	6	0	0
	3	5	4	0	0
	4	12	12	0	0
	5	12	7	0	0
	6	11	11	0	0

-* trial 9 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	9	300	150
	5	12	7	210	150
OUTS:	sub	x	y	bid	price
	2	9	10	0	210
	3	5	4	150	210
	4	12	12	0	360
	6	11	11	0	210

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	9	10	155	10
OUTS:	sub	x	y	bid	price
	1	7	9	0	0
	3	5	4	0	0
	4	12	12	10	155
	5	12	7	0	155
	6	11	11	10	155

-* trial 10 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	12	9	300	209
	2	3	6	77	0
	3	5	4	300	132
OUTS:	sub	x	y	bid	price
	4	12	12	0	377
	5	12	7	209	300
	6	11	11	100	377

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	4	12	12	100	0
OUTS:	sub	x	y	bid	price
	1	7	9	0	100
	2	3	6	0	0
	3	5	4	0	0
	5	12	7	0	100
	6	11	11	0	100

-* trial 11 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	4	12	12	110	80
	6	7	7	110	0
OUTS:	sub	x	y	bid	price
	5	9	10	80	110

-* trial 12 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	9	10	120	100
	6	7	7	110	0
OUTS:	sub	x	y	bid	price
	4	12	12	100	120

-* trial 13 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	9	10	120	71
	6	11	9	50	1
OUTS:	sub	x	y	bid	price
	4	12	12	121	170

-* trial 14 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	4	8	12	190	130
OUTS:	sub	x	y	bid	price
	5	9	10	120	180
	6	11	9	10	70

-* trial 15 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	4	8	12	200	180
OUTS:	sub	x	y	bid	price
	5	9	10	100	120
	6	9	9	80	[illegible]

Period 2

-* trial 1 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	15	14	150	125
OUTS:	sub	x	y	bid	price
	1	9	9	125	150
	2	12	13	0	150
	4	12	9	100	150
	5	8	12	80	150
	6	12	13	10	150

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	9	9	0	0
	2	12	13	0	0
	3	15	14	0	0
	4	12	9	0	0
	5	8	12	0	0
	6	12	13	0	0

-* trial 2 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	15	14	200	150
OUTS:	sub	x	y	bid	price
	1	9	9	150	200
	2	12	13	0	200
	4	12	9	110	200
	5	8	12	82	200
	6	12	13	10	200

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	9	9	0	0
	2	12	13	0	0
	3	15	14	0	0
	4	12	9	0	0
	5	8	12	0	0
	6	12	13	0	0

-* trial 3 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	4	3	99	0
	3	15	14	300	250
OUTS:	sub	x	y	bid	price
	1	9	9	150	290
	4	12	9	0	300
	5	8	12	250	300
	6	6	7	10	149

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	12	9	50	0
OUTS:	sub	x	y	bid	price
	1	9	9	0	50
	2	4	3	0	0
	3	15	14	0	50
	5	8	12	0	50
	6	6	7	0	0

-* trial 4 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	9	9	500	0
	4	5	9	400	0
OUTS:	sub	x	y	bid	price
	2	12	13	0	900
	3	15	14	250	900
	5	8	12	275	900
	6	12	13	150	900

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	9	9	0	0
	2	12	13	0	0
	3	15	14	0	0
	4	5	9	0	0
	5	8	12	0	0
	6	12	13	0	0

-* trial 5 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	9	9	500	150
	4	5	9	410	150
OUTS:	sub	x	y	bid	price
	2	12	13	0	810
	3	3	6	100	410
	5	8	12	275	810
	6	7	10	150	410

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	9	9	0	0
	2	12	13	0	0
	3	3	6	0	0
	4	5	9	0	0
	5	8	12	0	0
	6	9	10	0	0

-* trial 6 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	9	10	800	185
	4	5	9	415	150
OUTS:	sub	x	y	bid	price
	1	9	9	150	415
	2	4	3	0	415
	5	8	12	600	1215
	6	12	13	0	1215

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	4	3	99	0
	6	12	13	5	0
OUTS:	sub	x	y	bid	price
	1	9	9	0	5
	3	9	10	0	5
	4	5	9	0	5
	5	8	12	0	5

-* trial 7 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	4	12	9	395	300
OUTS:	sub	x	y	bid	price
	1	9	9	150	245
	2	12	13	0	395
	3	9	10	150	245
	5	12	10	235	395
	6	12	13	0	395

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	12	13	2	0
OUTS:	sub	x	y	bid	price
	1	9	9	0	2
	2	12	13	0	2
	3	9	10	0	2
	4	12	9	0	2
	5	12	10	0	2

-* trial 8 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	4	5	9	350	150
	6	9	10	1000	150
OUTS:	sub	x	y	bid	price
	1	9	9	150	350
	2	12	13	0	1250
	3	3	6	100	350
	5	8	12	300	1250

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	9	9	0	0
	2	12	13	0	0
	3	3	6	0	0
	4	5	9	0	0
	5	8	12	0	0
	6	9	10	0	0

-* trial 9 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	4	12	4	330	150
	5	8	12	2000	819
OUTS:	sub	x	y	bid	price
	1	9	9	350	2180
	2	12	13	0	2180
	3	3	6	150	330
	6	12	13	999	2180

MARKET 2 allocations:

INS:	sub	x	y	bid	price
OUTS:	sub	x	y	bid	price
	1	9	9	0	0
	2	12	13	0	0
	3	3	6	0	0
	4	12	4	0	0
	5	8	12	0	0
	6	12	13	0	0

-* trial 10 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	9	9	150	100
	3	9	10	200	101
OUTS:	sub	x	y	bid	price
	2	4	3	0	99
	4	12	9	250	350
	5	8	12	251	350
	6	9	10	100	150

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	4	3	99	0
OUTS:	sub	x	y	bid	price
	1	9	9	0	0
	3	9	10	0	0
	4	12	9	0	0
	5	8	12	0	0
	6	9	10	0	0

-* trial 11 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	5	4	10	0
	5	8	12	97	10
OUTS:	sub	x	y	bid	price
	2	12	13	0	97
	6	12	13	10	97

-* trial 12 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	12	13	100	97
OUTS:	sub	x	y	bid	price
	2	12	13	0	100
	4	5	9	1	100
	5	8	12	97	100

-* trial 13 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	12	9	200	101
OUTS:	sub	x	y	bid	price
	2	12	13	0	200
	5	8	12	101	200
	6	12	13	99	200

-* trial 14 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	12	13	9999	170
OUTS:	sub	x	y	bid	price
	2	12	13	0	9999
	4	12	9	170	9999
	5	8	12	92	9999

-* trial 13 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	6	10	50	0
	5	12	9	108	100
OUTS:	sub	x	y	bid	price
	2	8	8	0	50
	6	9	10	100	108

-* trial 14 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	8	8	200	50
	6	9	10	110	99
OUTS:	sub	x	y	bid	price
	3	6	10	50	110
	5	12	9	99	110

-* trial 15 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	8	10	222	50
	5	12	9	108	101
OUTS:	sub	x	y	bid	price
	3	6	10	50	108
	6	9	10	101	108

Period 4

Global Send error at Experiement end
Data not written to file

Final Trial Data (used full number
of trials for each market)

Market 1 ALLOCATIONS:

INS:	sub	x	y	bid	price
	2	6	7	?	90
	4	12	13	?	150

Martket 2 ALLOCATIONS:

OUTS:	sub	x	y	bid	price
	3	7	7	?	20
	1	12	12	?	70

Iterative Groves
Experiment 4

Period 1

-* trial 1 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	3	5	4	250	0
	5	9	13	200	200
OUTS:	sub	x	y	bid	price
	1	7	9	70	200
	2	3	6	0	130
	4	8	12	200	200
	6	11	11	0	200

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	3	6	102	0
	6	11	11	100	0
OUTS:	sub	x	y	bid	price
	1	7	9	0	100
	3	5	4	0	100
	4	8	12	0	100
	5	9	13	0	100

-* trial 2 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	3	70	0
	3	5	4	300	0
	4	8	12	211	130
OUTS:	sub	x	y	bid	price
	2	9	6	0	281
	5	9	10	200	281
	6	11	11	0	281

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	9	6	109	0
	6	11	11	50	0
OUTS:	sub	x	y	bid	price
	1	7	3	0	50
	3	5	4	0	50
	4	8	12	0	50
	5	9	10	0	50

-* trial 3 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	3	101	0
	3	5	4	300	99
	4	8	12	201	99
OUTS:	sub	x	y	bid	price
	2	9	6	0	302
	5	9	7	200	302
	6	11	11	0	302

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	9	6	109	0
	6	11	11	30	0
OUTS:	sub	x	y	bid	price
	1	7	3	0	30
	3	5	4	0	30
	4	8	12	0	30
	5	9	7	0	30

-* trial 4 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	3	100	0
	3	5	4	250	150
	5	6	7	9999	250
OUTS:	sub	x	y	bid	price
	2	9	6	0	100
	4	8	12	250	350
	6	11	11	0	350

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	9	6	109	0
	6	11	11	20	0
OUTS:	sub	x	y	bid	price
	1	7	3	0	20
	3	5	4	0	20
	4	8	12	0	20
	5	6	7	0	20

-* trial 5 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	3	100	0
	3	5	4	270	0
	5	6	13	200	0
OUTS:	sub	x	y	bid	price
	2	9	6	0	300
	4	8	12	0	200
	6	11	11	0	300

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	9	6	35	0
	4	8	12	21	10
OUTS:	sub	x	y	bid	price
	1	7	3	0	21
	3	5	4	0	21
	5	6	13	0	21
	6	11	11	10	21

-* trial 6 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	3	100	50
	3	5	4	270	200
	4	8	12	250	200
OUTS:	sub	x	y	bid	price
	2	9	6	300	350
	5	6	13	150	250
	6	11	11	0	320

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	6	11	11	15	0
OUTS:	sub	x	y	bid	price
	1	7	3	0	0
	2	9	6	0	0
	3	5	4	0	0
	4	8	12	0	15
	5	6	13	0	15

-* trial 7 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	3	100	0
	3	5	4	270	0
	5	6	13	250	150
OUTS:	sub	x	y	bid	price
	2	15	14	0	350
	4	8	12	150	250
	6	11	11	0	350

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	15	14	249	13
OUTS:	sub	x	y	bid	price
	1	7	3	0	236
	3	5	4	0	0
	4	8	12	0	249
	5	6	13	0	249
	6	11	11	13	249

-* trial 8 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	3	100	0
	3	5	4	250	24
	5	6	13	150	124
OUTS:	sub	x	y	bid	price
	2	3	6	124	150
	4	8	12	50	150
	6	11	11	0	250

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	6	11	11	15	0
OUTS:	sub	x	y	bid	price
	1	7	3	0	0
	2	3	6	0	0
	3	5	4	0	0
	4	8	12	0	15
	5	6	13	0	15

-* trial 9 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	1	7	3	100	0
	3	5	4	260	0
	5	6	13	124	50
OUTS:	sub	x	y	bid	price
	2	15	14	0	224
	4	8	12	50	124
	6	11	11	0	224

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	2	15	14	249	14
OUTS:	sub	x	y	bid	price
	1	7	3	0	235
	3	5	4	0	0
	4	8	12	0	249
	5	6	13	0	249
	6	11	11	14	249

-* trial 10 *-

MARKET 1 allocations:

	sub	x	y	bid	price
INS:	2	15	14	249	150
	3	5	4	260	50
OUTS:	sub	x	y	bid	price
	1	7	3	50	199
	4	8	12	100	149
	5	6	13	50	149
	6	11	11	0	249

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	6	11	11	15	0
OUTS:	sub	x	y	bid	price
	1	7	3	0	0
	2	15	14	0	15
	3	5	4	0	0
	4	8	12	0	15
	5	6	13	0	15

-* trial 11 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	12	13	75	70
OUTS:	sub	x	y	bid	price
	1	12	13	70	75
	4	8	12	50	75
	6	11	11	25	75

-* trial 12 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	5	12	13	80	75
	6	7	7	20	0
OUTS:	sub	x	y	bid	price
	1	12	13	75	80
	4	8	12	75	80

-* trial 13 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	1	4	3	25	20
	5	12	13	80	50
OUTS:	sub	x	y	bid	price
	4	6	8	50	80
	6	7	7	20	25

-* trial 14 *-

MARKET 2 allocations:

	sub	x	y	bid	price
INS:	1	4	3	35	0
	5	12	13	90	60
OUTS:	sub	x	y	bid	price
	4	12	12	60	80
	6	11	11	50	80

-* trial 15 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	4	3	35	10
	5	12	13	90	60
OUTS:	sub	x	y	bid	price
	4	12	12	65	90
	6	7	7	10	35

Period 2

-* trial 1 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	7	7	100	70
	5	12	12	9999	335
OUTS:	sub	x	y	bid	price
	2	12	13	335	9999
	3	15	14	200	10029
	4	5	4	70	100
	6	9	7	0	9999

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	9	7	29	0
OUTS:	sub	x	y	bid	price
	1	7	7	0	0
	2	12	13	0	29
	3	15	14	0	29
	4	5	4	0	0
	5	12	12	0	29

-* trial 2 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	7	9	201	100
	5	8	10	9999	100
OUTS:	sub	x	y	bid	price
	1	7	9	100	201
	3	3	6	100	201
	4	5	4	0	101
	6	9	7	0	201

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	5	4	10	0
	6	9	7	20	0
OUTS:	sub	x	y	bid	price
	1	7	9	0	10
	2	7	9	0	10
	3	3	6	0	0
	5	8	10	0	10

-* trial 3 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	3	6	300	150
	5	6	8	9999	150
OUTS:	sub	x	y	bid	price
	1	11	9	150	300
	2	12	13	0	9999
	4	5	4	0	0
	6	9	7	0	300

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	12	13	334	10
	4	5	4	10	0
OUTS:	sub	x	y	bid	price
	1	11	9	0	334
	3	3	6	0	10
	5	6	8	0	324
	6	9	7	10	334

-* trial 4 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	2	12	9	333	300
	5	8	10	9999	142
OUTS:	sub	x	y	bid	price
	1	11	7	175	333
	3	9	6	300	333
	4	5	4	50	333
	6	9	7	0	333

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	9	7	20	0
OUTS:	sub	x	y	bid	price
	1	11	7	0	0
	2	12	9	0	30
	3	9	6	0	0
	4	5	4	0	0
	5	8	10	0	0

-* trial 5 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	4	5	9	250	0
	6	12	10	9999	350
OUTS:	sub	x	y	bid	price
	1	7	7	0	250
	2	7	3	0	250
	3	9	6	350	9999
	5	8	12	0	9649

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	7	3	10	0
	4	8	12	333	0
OUTS:	sub	x	y	bid	price
	1	7	7	0	10
	3	9	6	0	10
	4	5	9	0	333
	6	12	10	0	333

-* trial 6 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	4	5	9	300	75
	6	12	10	100	75
OUTS:	sub	x	y	bid	price
	1	7	7	75	100
	2	7	3	0	100
	3	9	6	0	300
	5	8	12	0	325

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	7	3	20	10
	5	8	12	333	10
OUTS:	sub	x	y	bid	price
	1	7	7	0	20
	3	9	6	10	20
	4	5	9	0	333
	6	12	10	0	333

-* trial 7 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	4	5	9	280	135
	6	12	10	9999	135
OUTS:	sub	x	y	bid	price
	1	9	9	0	9999
	2	7	3	0	280
	3	3	10	135	280
	5	8	12	0	9999

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	7	3	20	0
	5	8	12	333	170
OUTS:	sub	x	y	bid	price
	1	9	9	170	333
	3	3	10	0	183
	4	5	9	0	183
	6	12	10	0	333

Period 3

-* trial 1 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	5	5	4	20	0
	6	12	10	200	120
OUTS:	sub	x	y	bid	price
	1	12	13	0	200
	2	9	9	40	200
	3	12	13	120	200
	4	9	6	40	200

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	13	40	0
OUTS:	sub	x	y	bid	price
	2	9	9	0	40
	3	12	13	0	40
	4	9	6	0	40
	5	5	4	0	0
	6	12	10	0	40

-* trial 2 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	12	9	260	30
	6	6	8	50	30
OUTS:	sub	x	y	bid	price
	1	12	13	0	280
	2	7	11	0	50
	4	3	6	30	50
	5	12	9	5	260

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	7	11	50	40
OUTS:	sub	x	y	bid	price
	1	12	13	40	50
	3	12	9	0	0
	4	3	6	0	0
	5	12	9	0	0
	6	6	8	0	0

-* trial 3 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	12	9	260	250
	4	3	6	30	0
OUTS:	sub	x	y	bid	price
	1	12	13	0	260
	2	11	11	250	260
	5	12	9	200	260
	6	12	10	100	260

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	13	40	0
OUTS:	sub	x	y	bid	price
	2	11	11	0	40
	3	12	9	0	40
	4	3	6	0	0
	5	12	9	0	40
	6	12	10	0	40

-* trial 4 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	3	12	9	260	100
	6	6	8	75	50
OUTS:	sub	x	y	bid	price
	1	6	7	50	75
	2	9	9	100	260
	4	3	6	0	75
	5	3	2	0	0

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	4	3	6	5	0
OUTS:	sub	x	y	bid	price
	2	9	9	0	0
	3	12	9	0	0
	5	3	2	0	0
	6	6	8	0	0

-* trial 5 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	13	270	260
	4	3	6	25	0
OUTS:	sub	x	y	bid	price
	2	7	11	0	270
	3	12	9	260	270
	5	5	4	0	25
	6	12	10	200	270

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	7	11	10	0
	5	5	4	5	0
OUTS:	sub	x	y	bid	price
	1	12	13	0	10
	4	3	6	0	5
	6	12	10	0	10

-* trial 6 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	13	270	270
	4		6	50	30
OUTS:	sub	x	y	bid	price
	2	7	11	0	270
	3	12	9	270	270
	5	5	4	30	25
	6	12	10	0	270

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	12	10	20	15
OUTS:	sub	x	y	bid	price
	1	12	13	0	20
	2	7	11	15	20
	3	12	9	0	20
	4	3	6	0	0
	5	5	4	0	0

-* trial 7 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	13	275	270
	4	3	6	75	0
OUTS:	sub	x	y	bid	price
	2	7	11	0	275
	3	12	9	0	275
	5	5	4	0	75
	6	12	10	270	275

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	7	11	50	40
	5	5	4	15	0
OUTS:	sub	x	y	bid	price
	1	12	13	0	50
	3	12	9	40	50
	4	3	6	0	0
	6	12	10	0	50

-* trial 8 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	13	275	50
	4	3	6	75	50
OUTS:	sub	x	y	bid	price
	2	7	11	0	275
	3	7	3	50	75
	5	5	4	0	75
	6	6	8	0	275

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	2	7	11	50	30
	6	6	8	50	30
OUTS:	sub	x	y	bid	price
	1	12	13	0	50
	3	7	3	0	50
	4	3	6	0	50
	5	5	4	30	50

-* trial 9 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	13	275	200
	4	3	6	100	75
OUTS:	sub	x	y	bid	price
	2	7	11	200	275
	3	7	3	75	100
	5	5	4	60	100
	6	6	8	0	275

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	6	8	50	0
OUTS:	sub	x	y	bid	price
	1	12	13	0	50
	2	7	11	0	0
	3	7	3	0	0
	4	3	6	0	0
	5	5	4	0	0

-* trial 10 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	12	13	275	270
	4	3	6	100	80
OUTS:	sub	x	y	bid	price
	2	7	7	80	100
	3	12	13	270	275
	5	12	9	200	275
	6	6	8	0	275

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	6	8	50	0
OUTS:	sub	x	y	bid	price
	1	12	13	0	50
	2	7	7	0	0
	3	12	13	0	50
	4	3	6	0	0
	5	5	4	[illegible]	0

-* trial 11 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	12	9	100	60
	5	5	4	75	50
OUTS:	sub	x	y	bid	price
	2	9	11	60	100
	6	6	8	50	75

-* trial 12 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	12	13	100	75
OUTS:	sub	x	y	bid	price
	2	11	11	15	25
	6	6	8	10	25
	5	5	9	75	85

-* trial 13 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	12	13	100	75
	5	5	4	75	50
OUTS:	sub	x	y	bid	price
	2	11	11	60	100
	6	6	8	50	75

-* trial 14 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	12	13	100	90
	5	5	4	90	60
OUTS:	sub	x	y	bid	price
	2	11	11	90	100
	6	6	8	60	90

-* trial 15 *-

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	3	12	13	100	90
	5	5	4	90	80
OUTS:	sub	x	y	bid	price
	2	11	11	90	100
	6	6	8	80	90

Period 4

Global Send Error
Final trial allocations only
(bids lost)

-* trial 15 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	4	12	13	?	200
	6	5	4	?	45

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	1	12	12	?	75
	2	6	7	?	50

Period 5

Global Send Error
Final trial allocations only
(bids lost)

-* trial 15 *-

MARKET 1 allocations:

INS:	sub	x	y	bid	price
	1	5	4	?	65
	5	12	13	?	95

MARKET 2 allocations:

INS:	sub	x	y	bid	price
	6	15	14	?	50

Experiment 1
Random Mechanism

Period 1

Market 1

Sub	X	Y
4	9	10
1	3	2

Market 2

Sub	X	Y
2	8	12
5	9	6

Excluded Orders

Sub	X	Y	Rankings
3	9	9	1,2
6	12	9	1,2

Period 2

Market 1

Sub	X	Y
1	7	3
4	9	9

Market 2

Sub	X	Y
6	9	10
2	5	4

Excluded Orders

Sub	X	Y	Rankings
3	8	10	1,2
5	9	7	1,2

Experiment 2
Random Mechanism

Period 1

Market 1

Sub	X	Y
5	9	10
4	8	10

Market 2

Sub	X	Y
6	9	9
2	6	10

Excluded Orders

Sub	X	Y	Rankings
3	7	3	1,2
1	5	4	1,2

Period 2

Market 1

Sub	X	Y
1	11	9
4	7	9

Market 2

Sub	X	Y
3	12	10
2	5	4

Excluded Orders

Sub	X	Y	Rankings
5	8	12	1,2
1	9	10	1,2

Period 3

Market 1

Sub	X	Y
5	9	10
2	9	10

Market 2

Sub	X	Y
4	8	12
1	5	4

Excluded Orders

Sub	X	Y	Rankings
3	7	7	1,2
6	9	9	1,2

Experiment 3
Random Mechanism

Period 1

Market 1

Sub	X	Y
3	12	12
5	3	6

Market 2

Sub	X	Y
2	5	4
4	9	9
1	4	3

Excluded Orders

Sub	X	Y	Rankings
6	9	10	1,2

Period 2

Market 1

Sub	X	Y
1	3	2
3	9	9
5	6	7

Market 2

Sub	X	Y
4	9	10
2	8	10

Excluded Orders

Sub	X	Y	Rankings
6	7	9	1,2

Experiment 4
Random Mechanism

Period 1

Market 1

Sub	X	Y
4	12	12

Market 2

Sub	X	Y
2	15	14

Excluded Orders

Sub	X	Y	Rankings
1	12	9	1,2
3	12	9	1,2
5	9	10	1,2
6	9	9	1,2

Period 2

Market 1

Sub	X	Y
4	12	9

Market 2

Sub	X	Y
2	12	3
6	6	13

Excluded Orders

Sub	X	Y	Rankings
1	9	9	1,2
3	9	14	1,2
5	8	10	1,2

Period 3

Market 1

Sub	X	Y
2	7	9
4	9	6

Market 2

Sub	X	Y
1	6	7
5	5	4
6	6	8

Excluded Orders

Sub	X	Y	Rankings
3	7	3	1,2

Period 4

Market 1

Sub	X	Y
2	9	10
6	5	4

Market 2

Sub	X	Y
3	9	9
4	7	3

Excluded Orders

Sub	X	Y	Rankings
1	6	10	1,2
5	9	6	1,2

Period 5

Market 1

Sub	X	Y
1	12	9
4	7	9

Market 2

Sub	X	Y
2	8	10
6	9	10

Excluded Orders

Sub	X	Y	Rankings
3	9	10	1,2
5	12	9	1,2

Experiment 5
Random Mechanism

Period 1

Market 1

Sub	X	Y
4	11	11

Market 2

Sub	X	Y
6	8	12

Excluded Orders

Sub	X	Y	Rankings
1	12	13	1,2
2	9	10	1,2
3	12	9	1,2
5	8	10	1,2

Period 2

Market 1

Sub	X	Y
1	7	9
6	12	10

Market 2

Sub	X	Y
3	9	10

Excluded Orders

Sub	X	Y	Rankings
2	12	9	1,2
5	9	10	1,2
4	8	10	1,2

Period 3

Market 1

Sub	X	Y
1	9	9
4	9	10

Market 2

Sub	X	Y
2	9	7
6	8	12

Excluded Orders

Sub	X	Y	Rankings
3	12	9	1,2
5	5	4	1,2

Period 4

Market 1

Sub	X	Y
2	6	7
4	7	3
5	3	6
6	3	2

Market 2

Sub	X	Y
1	6	8
3	7	9

Excluded Orders

Sub	X	Y	Rankings

Period 5

Market 1

Sub	X	Y
1	5	4
4	9	10

Market 2

Sub	X	Y
2	8	8
5	12	9

Excluded Orders

Sub	X	Y	Rankings
3	9	10	1,2
4	7	9	1,2

Experiment 1
ASUM with Queue
Period 1

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
1	11	11	100	6	12	13	50	4	5	9	100	1
3	9	6	100	5	9	10	25	3	3	6	25	2
6	4	3	25	2	8	10	50	1	7	7	50	1
4	5	9	100	1	9	9	30	6	12	13	40	2
3	9	14	110	5	9	10	45	3	3	6	60	1
6	7	13	110	5	12	10	50					
1	7	7	105	3	9	6	55					
4	5	9	125	5	9	13	30					
2	12	12	130	2	12	12	90					
6	12	13	135	6	12	13	55					
4	12	4	150	3	3	6	40					
5	6	13	110	8	12	12	60					
2	8	12	115	5	6	7	5					
3	3	14	100	1	7	7	10					
6	7	9	105	5	6	7	15					
5	12	10	155	1	7	7	10					
3	3	10	110	3	3	6	35					
6	7	9	115	6	12	13	40					
1	5	9	125	2	12	12	50					
6	7	9	135	5	12	13	55					
1	11	11	160	2	12	12	60					
4	12	9	175	4	5	4	50					
1	11	11	180									
5	12	10	185									

Period 2

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
3	5	9	70	6	11	11	10	4	9	10	100	1
6	11	9	75	2	15	14	15	4	9	10	150	1
2	9	10	50	6	11	11	25					
4	9	10	100	2	15	14	45					
1	8	10	100	3	3	4	30					
5	12	9	105									
3	5	9	130									
1	12	10	110									
5	12	9	115									
1	12	10	120									
5	12	9	130									
1	12	10	150									
5	12	9	155									
1	8	10	135									
6	11	11	140									
6	7	9	140									
1	8	10	145									

Period 3

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
2	5	9	10	5	11	11	25	4	7	9	100	1
6	12	12	100	2	12	9	30	1	15	6	100	1
3	9	10	120	5	7	11	25	4	12	3	100	1
4	7	9	100	6	8	10	30					
5	11	9	105	5	11	9	35					
4	7	9	125	2	12	9	40					
6	12	10	125	5	7	11	35					
3	9	10	130	6	8	10	40					
1	9	10	130	1	9	10	45					
3	9	10	140	2	12	9	50					
1	11	9	140									
5	9	10	145									
3	9	10	150									
5	11	9	150									

Period 4

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
6	15	14	130	5	12	12	25	5	12	12	50	2
2	12	13	135	6	3	6	5	5	8	10	100	1
6	15	14	140	2	12	13	55	2	9	10	150	1
3	12	9	180	2	6	7	15	5	8	12	175	1
2	6	10	50	5	12	12	50	3	12	9	180	1
1	5	9	130	6	3	6	30	5	8	12	175	1
5	8	10	100	2	12	13	55	5	12	12	200	1
5	8	12	175	3	7	13	40	5	8	12	200	1
2	12	7	140	2	12	13	45	3	12	9	200	1
1	12	4	155	5	12	12	50					
3	12	9	180	1	5	4	35					
2	6	10	155	6	15	14	55					
3	12	9	185	2	12	13	60					
3	12	9	190	6	15	14	65					
5	8	10	160	2	12	13	70					
6	9	6	160									
5	8	12	200									

Period 5

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
4	12	12	100	2	11	11	50	5	3	6	20	1
3	12	9	180	5	3	6	10	4	12	12	150	1
6	5	9	75	6	5	9	20	2	11	11	175	1
1	12	10	190	5	9	6	25	5	3	6	30	2
4	8	10	100	6	5	9	30	5	9	10	50	2
6	5	9	120	5	9	6	50	5	9	10	60	2
3	12	9	195	6	5	9	55					
1	12	10	200	5	15	10	55					
3	12	9	205	2	11	11	60					
1	12	10	210	5	9	10	40					
3	12	9	215	3	7	9	45					
1	6	10	150	2	11	11	50					
2	11	11	175	5	9	10	55					
6	5	9	200	2	11	11	60					
1	12	10	180	5	9	6	50					
3	12	9	200	1	9	7	55					
1	12	10	205	5	9	6	60					
3	12	9	210	1	9	7	65					
1	12	10	215	2	11	11	70					
3	12	9	220									

Experiment 2
ASUM with Queue

Period 1

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid	Standby Queue sub	X	Y	Bid	Market
5	12	13	25	1	7	7	0	2	6	8	20	1
3	9	10	100	6	4	3	5	4	5	4	50	1
1	11	9	50	2	6	10	10	3	9	10	90	1
4	5	4	50	6	12	13	0	1	11	11	75	1
5	12	13	105	2	6	8	10	4	5	4	50	1
6	7	3	55	6	12	9	0	1	7	9	50	1
2	6	10	60	2	12	12	15	4	5	4	50	1
4	5	4	50	3	15	14	20	3	3	6	55	1
3	9	10	110	6	12	13	0	1	9	9	100	1
1	11	9	65	1	7	7	0	1	11	11	150	1
5	6	7	70	3	9	10	10	6	12	13	20	2
1	11	9	75	6	12	9	15	3	9	10	20	2
2	8	10	80	3	9	10	20	1	7	9	100	1
1	11	9	85	6	12	13	25	4	5	4	100	1
5	9	10	90	3	15	14	30	3	3	6	60	1
1	11	9	105	2	12	12	40	3	3	6	65	1
5	9	10	115	6	7	3	0	4	5	4	90	1
1	11	9	115	4	5	4	10	3	3	6	70	1
3	9	10	90	3	15	4	45	4	5	4	80	1
2	6	10	145	6	12	13	0					
6	12	9	95	2	8	10	5					
5	12	10	100	3	9	10	15					
1	11	9	105	6	12	9	20					
3	9	10	110	3	15	14	30					
1	11	9	115	6	4	3	0					
5	12	10	120	2	12	12	35					
1	11	9	125	6	7	3	5					
5	12	10	130	3	3	6	10					
1	12	10	135	6	12	13	40					
5	12	10	150	4	5	4	20					
1	11	9	155	3	15	14	45					
5	12	10	175	6	12	13	50					
1	11	9	180	3	3	6	25					
5	9	10	150	4	12	4	60					
3	3	6	55	1	11	11	0					
4	5	4	100	5	12	13	25					
5	9	10	160	1	7	7	0					
2	8	10	165	3	15	14	35					
5	9	10	175	5	12	13	50					
6	12	9	205	3	3	6	10					
3	3	6	65	4	5	4	20					
4	5	4	90	3	15	14	50					
2	8	10	160	5	12	13	60					
5	9	10	165									

Period 2

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid	Standby Queue sub	X	Y	Bid	Market
5	12	13	50	6	11	11	0	1	8	10	100	1
1	3	6	10	2	15	14	5	2	3	6	20	1
3	5	4	25	5	12	10	35	1	8	8	75	1
1	12	12	55	2	15	14	5	3	5	4	50	1
5	12	13	60	6	11	11	10	2	3	10	40	1
1	12	12	65	4	9	10	15	3	5	4	60	1
5	12	13	75	4	12	13	15	3	5	4	75	1
1	12	12	100	6	7	7	0	3	5	4	75	1
5	12	13	125	3	5	4	20	2	3	6	40	1
1	12	12	130	6	11	11	20	1	8	12	150	1
1	8	8	75	3	5	4	15					
6	11	11	100	2	3	6	5					
5	12	9	125	5	12	13	25					
1	8	10	80	6	11	11	30					
3	5	4	50	5	12	13	50					
2	3	6	20	4	6	7	25					
3	12	9	130									
5	12	9	135									
3	5	4	50									
2	3	6	35									
1	8	10	90									
4	12	10	140									
5	12	9	145									
3	5	4	75									
2	3	6	20									
1	8	10	100									
3	5	4	75									
2	3	6	35									
1	12	10	150									
5	12	13	190									
1	12	12	175									
4	6	7	90									
3	5	4	95									

Period 3

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid	Standby Queue sub	X	Y	Bid	Market
5	11	11	10	5	11	11	25	6	12	12	150	1
6	12	12	150	6	12	12	30	1	3	6	60	1
3	12	13	175	5	7	7	5	6	8	8	75	1
2	5	4	20	5	11	11	40	3	9	10	160	1
1	3	6	25	4	7	9	10					
2	5	4	30	3	12	13	55					
1	3	6	35	2	3	6	0					
2	5	4	40	6	12	12	20					
1	3	6	45	3	12	13	30					
2	5	4	50	6	12	12	40					
1	3	6	55	3	12	13	50					
2	5	4	60	6	12	12	55					
1	15	14	180	3	12	13	60					
3	12	13	185	4	4	3	10					
1	15	14	190									
3	12	13	185									
1	15	14	190									
3	12	13	195									
1	15	14	200									
5	11	11	210									
4	7	9	70									
6	8	8	75									
2	5	9	80									
4	7	9	90									
2	5	9	80									
4	7	9	90									
2	5	9	100									
3	9	7	110									
2	5	9	115									
1	9	6	120									
2	5	9	125									

Period 4

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid	Standby Queue sub	X	Y	Bid	Market
3	12	9	180	6	15	14	20	1	5	4	90	1
5	8	10	50	5	12	12	25	1	5	4	80	1
1	5	4	55	6	15	14	30	1	5	4	95	1
2	6	10	60	1	5	4	0	2	6	7	90	1
1	5	4	65									
2	6	10	70									
5	8	10	75									
1	5	4	90									
2	6	10	180									
5	12	10	85									
3	12	9	170									
1	12	9	175									
3	12	9	185									
5	8	10	195									

Period 5

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid	Standby Queue sub	X	Y	Bid	Market
5	12	13	125	2	12	12	0	2	6	8	30	1
6	12	13	170	5	12	13	10	2	6	8	50	1
3	3	6	25	2	12	12	15					
3	3	6	55	1	7	7	0					
5	12	13	175	5	12	13	20					
6	12	13	180	6	12	12	70					
2	12	12	185	3	3	6	30					
5	12	13	190									
4	5	4	105									
2	12	12	195									
5	12	13	235									

Experiment 3
ASUM with Queue

Period 1

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
1	12	13	10	3	3	2	0	6	11	11	10	1
2	12	12	20	4	8	10	10	3	12	9	10	1
5	6	7	10	1	12	9	10	5	12	13	60	1
6	7	7	20	3	12	9	15	2	3	10	10	1
5	12	13	50	1	12	9	20	2	3	6	20	1
3	12	13	75	5	12	10	30	6	7	7	20	1
5	6	7	30	2	9	10	40	2	9	10	10	1
6	11	11	80	5	9	10	20	2	15	14	150	1
2	3	6	20	4	8	10	30	5	6	7	100	1
3	5	2	25	2	9	10	50	5	9	10	10	2
1	12	9	90	5	12	10	60	2	9	10	30	2
6	7	11	50	6	11	11	75					
3	12	9	125	5	12	10	80					
1	12	9	130	2	9	10	85					
3	12	9	150	5	12	10	90					
1	12	9	175									
3	12	9	190									
1	7	9	55									
6	7	9	75									
1	7	9	80									
6	7	9	100									
1	7	9	110									

Period 2

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
6	12	9	20	1	15	14	5	1	15	14	30	1
2	5	4	20	5	11	11	10	3	12	12	40	1
2	5	9	25	3	8	10	10	5	7	9	15	2
3	12	10	50	4	12	10	20	5	11	11	100	1
6	12	9	75	5	7	9	15	3	12	10	120	1
3	12	10	90	3	8	10	20	3	8	12	90	1
6	12	9	100	4	12	13	45	3	12	12	10	2
3	12	10	120	1	3	6	51	1	15	10	200	1
6	12	9	125	5	7	7	15	5	7	7	25	2
3	12	10	150	1	3	6	20					
5	7	9	30	5	7	7	25					
2	5	9	100	1	3	6	30					
6	12	9	175	5	11	11	70					
1	15	10	200	4	12	13	75					
6	12	9	220	3	12	12	85					
3	8	10	125	4	12	13	95					
2	5	9	130									
3	8	10	150									
2	5	9	160									
3	8	10	170									
2	5	9	175									

Period 3

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
2	8	8	70	1	12	9	25	1	5	4	10	2
3	12	10	25	4	7	11	30	2	8	10	50	1
6	9	10	50	5	12	9	30	2	12	12	60	1
3	12	10	75	2	8	10	35					
1	5	9	75	6	9	10	40					
5	12	9	100	5	12	9	45					
3	12	10	125	6	9	10	60					
5	12	9	150	5	12	9	65					
4	7	9	100	4	7	11	50					
1	5	9	110	2	8	10	60					
4	7	9	125	6	9	10	100					
1	5	9	160	5	12	9	105					
6	15	10	190									
3	12	10	200									
6	15	10	205									
3	12	10	210									

Period 4

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
1	12	12	50	2	12	13	10	1	12	12	40	1
3	7	7	25	1	12	12	50	3	11	11	50	1
5	9	10	60	2	12	13	60	4	12	9	70	1
6	5	4	30	5	15	14	75	3	9	9	75	1
5	15	14	100	6	5	4	15	3	11	11	100	1
3	7	9	90	1	12	12	80					
4	12	9	70	2	6	7	20					
3	9	9	75	6	5	4	25					
1	8	10	75	2	12	13	90					
4	12	9	100	5	15	14	100					
2	12	10	125									
4	12	9	150									
2	6	10	90									
1	8	10	100									
2	12	10	175									
4	12	9	185									
2	6	10	125									
1	8	10	130									
2	6	10	140									
1	8	10	150									
2	6	10	155									
1	8	10	160									

Period 5

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
3	12	13	100	3	12	13	20	6	12	12	90	1
6	12	12	110	2	7	7	10	5	5	4	40	1
1	6	7	90	5	5	4	15	4	15	4	60	1
5	5	4	100	2	7	7	20	4	3	6	50	1
1	6	7	110	3	12	13	30					
5	5	4	115	5	5	4	25					
1	6	7	120	4	15	14	30					
4	9	10	115	3	12	13	40					
1	12	7	120	4	15	14	50					
6	8	12	125	3	12	13	40					
4	9	10	150	2	7	7	35					
1	12	7	155	5	5	4	40					
2	11	9	160	4	15	14	75					
1	12	7	165	3	12	13	80					
2	7	11	135	4	15	14	85					
6	8	12	140	3	12	13	90					

Experiment 4
ASUM with Queue

Period 1

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
2	12	12	100	4	3	2	50	4	5	4	70	2
5	6	7	65	1	9	11	60	4	5	9	80	1
3	9	6	105	6	4	3	10	4	12	9	100	1
2	12	12	110	4	3	9	65	1	7	7	20	2
3	9	6	115	1	11	11	70					
6	12	13	120	2	12	12	70					
1	11	11	190	6	12	3	75					
6	7	9	70	2	12	12	80					
5	12	10	185	6	12	13	85					
1	7	7	85	3	3	6	5					
6	7	9	90	4	5	4	10					
1	7	7	95	3	3	6	15					
1	7	9	100	4	5	4	20					
1	7	9	190	3	3	6	40					
5	12	10	125	4	5	4	50					
4	12	9	130	3	3	6	40					
5	12	10	150	4	12	9	90					
6	12	9	155	3	3	10	45					
6	12	9	155	6	7	9	50					
5	12	10	165									
6	12	9	170									
5	12	10	180									
6	12	9	185									
5	12	10	200									
6	12	9	205									
5	12	10	210									
6	12	9	215									
5	12	10	220									
6	12	9	225									
5	12	10	230									

Period 2

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
3	5	4	50	1	12	12	50	5	7	9	55	1
4	12	13	30	2	3	6	20	4	9	10	90	1
6	11	11	40	4	6	10	55	4	6	13	60	2
4	12	13	50	1	12	12	60					
6	11	11	60	6	7	7	25					
4	12	13	70	1	12	12	70					
6	11	11	80	6	7	7	75					
4	12	13	90	1	12	12	90					
6	11	11	100	6	7	7	100					
4	12	13	120	1	12	12	105					
6	11	11	125	6	7	7	110					
4	12	13	130	1	12	12	120					
6	11	11	135	4	6	7	35					
5	7	9	55									
3	5	4	60									
5	7	9	75									
3	5	4	80									
5	7	9	95									
3	5	4	110									
5	12	13	200									
4	6	7	115									
3	12	9	215									
5	12	13	220									
3	12	9	230									
5	12	13	250									
3	5	4	100									

Period 3

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
6	8	12	100	1	15	14	60	1	3	6	40	1
5	11	7	65	2	5	4	15	5	9	9	75	1
3	12	7	75	1	15	14	60	5	7	9	100	1
4	12	9	150	3	12	13	100	1	9	10	50	1
6	8	8	50	1	15	14	105					
3	12	7	160	3	12	13	110					
4	12	9	170	1	15	14	120					
3	12	7	180	4	4	3	30					
4	12	9	200	2	5	4	20					
3	12	7	210									
4	12	9	215									
3	12	10	230									
5	7	9	75									
6	8	8	80									
5	7	9	100									
6	8	8	105									
5	7	9	115									
6	8	8	120									
5	7	9	130									
4	12	9	235									
6	8	10	135									

Period 4

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
3	7	9	40	2	6	7	20	5	8	8	25	1
4	11	11	30	4	11	11	25	4	1	9	170	1
1	12	9	35	6	9	10	30	5	12	12	210	1
4	11	11	50	4	11	11	35	5	8	12	195	1
1	12	9	60	6	9	10	40	5	12	12	225	1
4	11	11	75	4	11	11	50					
1	12	9	80	6	9	10	60					
4	11	11	90	1	5	4	25					
1	12	9	100	2	9	10	30					
4	11	11	120	1	5	4	35					
1	12	9	125	2	9	10	50					
5	8	10	70	1	5	4	60					
3	7	9	100	4	11	11	70					
5	12	10	135	1	12	9	135					
1	12	9	140	4	7	9	5					
5	12	10	150	6	3	6	20					
2	6	10	90	4	7	9	30					
4	11	9	170	6	3	6	35					
3	12	9	200	4	7	9	50					
5	8	10	110									
4	7	11	135									
5	8	10	140									
4	7	11	145									
5	8	10	155									
4	7	11	170									
5	8	10	175									

Period 5

Market 1				Market 2				Standby Queue				
sub	X	Y	Bid	sub	X	Y	Bid	sub	X	Y	Bid	Market
5	15	14	150	3	9	9	30	4	12	12	110	1
6	5	4	50	1	12	13	50	5	9	10	100	1
2	12	9	160	3	7	7	15	3	9	9	75	1
4	8	10	55	5	3	6	20	3	11	11	40	2
5	3	10	75	3	7	7	25					
4	8	10	105	5	3	6	30					
6	5	9	110	3	7	7	35					
4	8	10	120	2	12	9	55					
6	5	9	125	1	12	13	60					
4	12	10	165									
2	12	9	170									
4	12	10	175									
2	12	9	185									
4	12	10	190									
2	12	9	200									
4	12	10	205									
2	12	9	215									
4	12	10	220									
2	12	9	230									
4	12	10	235									
2	12	9	240									
4	12	10	245									

Experiment 1
ASUM

Period 1

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
2	6	8	20	5	12	13	25
4	12	9	50	3	3	6	30
2	8	10	25	5	12	13	25
2	6	10	30	1	11	11	30
2	8	10	50	5	12	13	35
6	7	9	55	2	8	10	50
4	12	9	60	5	9	10	30
2	8	10	75	1	9	9	35
3	15	14	104	5	9	10	40
4	5	4	50	5	12	13	55
				1	9	9	55
				5	9	10	55
				2	8	10	60
				5	9	10	70

Period 2

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
4	12	13	50	2	5	9	50
1	12	12	55	5	12	3	50
4	12	13	75	5	12	9	55
1	12	12	150	6	7	11	50
4	12	13	155	1	8	10	60
1	12	12	160				
4	6	7	30				
2	3	6	40				
4	12	13	175				
6	7	7	45				
2	3	6	60				
3	5	9	180				
4	12	10	150				

Period 3

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
3	12	13	75	5	9	9	25
1	15	14	80	3	12	13	30
4	12	9	100	1	15	14	80
3	12	13	105	3	12	13	100
1	15	14	160	1	3	6	30
4	12	9	175				
3	12	13	190				
1	3	6	80				
4	7	3	75				
4	12	13	200				
2	12	12	205				
4	12	13	210				
2	5	4	90				

Period 4

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
2	12	9	60	5	12	12	25
1	12	9	85	6	15	14	50
3	12	9	100	1	5	4	10
2	12	9	105	5	8	12	55
4	7	9	40	1	12	9	70
5	8	10	50	5	8	10	25
2	12	10	140				
1	12	9	145				
2	12	10	160				
4	7	9	55				
1	12	9	180				
3	4	3	60				
2	12	13	200				

Period 5

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
1	12	13	180	3	7	7	25
2	7	3	50	5	9	10	20
4	8	12	200	2	12	13	30
6	12	4	100	5	9	10	35
1	12	7	105	2	12	13	45
6	12	4	110	5	3	6	30
1	12	7	115	6	5	4	35
6	12	4	120	5	15	14	50
1	12	7	125	3	11	11	60
6	12	4	150	5	9	6	40
1	12	7	155	6	5	9	50
				2	12	9	70

Experiment 3
ASUM

Period 1

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
5	12	9	50	3	8	12	50
6	6	7	50	2	11	7	40
2	7	11	55	4	15	14	45
4	15	14	110				
5	5	4	50				
6	12	13	115				
3	12	12	120				
6	12	13	125				
3	12	12	130				
6	12	13	135				
3	12	12	140				
6	12	13	145				
3	12	12	150				
2	11	11	155				
3	12	12	160				
1	12	13	165				
3	12	12	170				
1	11	11	175				
3	12	12	180				
1	11	11	185				
3	12	12	190				
1	11	11	195				
3	12	12	200				

Period 2

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
6	9	11	50	1	12	12	5
5	12	9	60	6	11	11	10
4	6	10	90	1	12	12	15
3	5	4	65	3	5	4	10
5	12	9	90	4	12	13	90
1	12	10	95	2	3	6	15
5	12	9	100	3	5	4	20
1	12	10	105	2	3	6	35
5	12	9	110	3	5	4	40
1	12	10	115	2	3	6	10
5	12	9	120	5	3	4	5
1	12	10	130	6	7	7	10
5	12	9	150	5	5	4	20
1	12	10	155	6	7	7	25
5	12	9	160	1	12	12	85
1	6	10	95	4	12	13	90
2	9	10	170				
5	12	9	175				
1	12	12	180				
5	7	3	25				
3	5	4	45				
5	7	3	50				
3	5	4	55				
5	7	3	60				
3	5	4	65				
5	7	3	70				
3	5	4	75				
2	3	6	90				
3	5	4	95				
2	3	6	100				
3	5	4	105				
2	3	6	110				
3	5	4	115				
5	12	13	185				
1	12	12	190				
5	12	13	195				
1	12	12	200				
5	12	13	205				
2	15	14	210				

Period 3

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
6	9	6	50	4	11	11	50
3	12	9	55	6	3	6	10
6	9	6	60	3	12	9	55
3	12	9	100	4	7	7	15
1	5	9	55	6	3	6	20
5	8	10	60	4	7	7	25
1	5	9	70	6	3	6	30
5	8	10	75				
2	12	13	200				
3	12	9	205				
1	5	9	5				
5	8	10	10				
1	5	9	15				
5	8	10	50				
2	6	10	125				
1	5	9	130				
2	6	10	135				
1	5	9	140				
2	12	10	210				
3	12	9	215				
2	12	10	220				
5	8	10	145				

Period 4

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
3	9	6	50	4	12	9	50
5	12	13	75	3	15	14	60
3	9	6	80	4	5	4	25
5	12	13	85				
3	9	6	90				
5	12	13	100				
3	3	6	25				
1	7	7	30				
3	3	6	35				
1	7	7	40				
3	3	6	50				
6	12	13	110				
5	12	13	125				
6	12	13	130				
5	12	13	135				
6	12	13	140				
5	12	13	175				
6	12	13	200				
5	6	7	75				
3	3	6	80				
5	6	7	85				
3	3	6	90				
5	6	7	100				
2	12	12	210				
6	12	13	215				
2	12	12	220				
6	12	13	230				

Period 5

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
3	9	10	50	4	12	13	25
2	5	9	75	1	15	14	35
5	11	9	60	4	4	3	5
3	9	10	65	5	11	11	50
5	11	9	75	4	7	9	10
3	9	10	80	1	9	6	15
2	5	4	100	4	7	9	20
5	11	9	100	1	9	6	25
3	9	10	105	4	7	9	30
5	11	9	100	1	9	6	35
2	5	9	125	4	7	9	40
5	11	11	110	1	9	6	45
3	9	10	120	4	7	13	55
5	11	11	140	5	11	11	60
3	9	10	145	1	15	14	65
5	11	11	150	4	4	3	5
3	9	10	155				
5	11	11	160				
3	9	10	165				
5	11	11	175				
3	9	10	180				
5	11	9	130				
2	5	9	150				
3	12	10	185				

Experiment 2
ASUM
Period 1

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
1	12	9	75	6	9	11	10
4	8	10	50	5	9	7	10
2	9	10	100	1	12	9	25
1	12	9	105	6	7	9	5
3	5	9	55	4	12	10	30
2	9	10	120	5	6	7	10
4	12	10	125	1	12	13	50
2	3	10	60	6	7	7	15
1	12	9	130	5	6	7	20
3	5	4	75	6	7	7	30
4	12	12	150				
2	3	6	85				
3	5	4	100				
5	6	7	105				
3	5	4	110				

Period 2

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
5	12	12	100	5	12	12	10
2	12	13	150	6	9	10	15
4	5	4	30	5	8	10	10
3	15	10	160	5	12	12	30
1	11	11	170	5	8	10	40
2	12	13	175	3	9	10	10
3	3	6	35	6	6	7	15
1	7	7	50	3	9	10	35
4	5	4	55	6	9	10	40
1	11	11	180	3	9	10	45
2	12	13	185				
3	3	6	60				
1	7	7	65				
4	5	4	70				
3	3	6	75				
1	11	11	190				
2	12	13	200				
4	5	4	80				
6	6	7	85				
4	5	4	90				
6	6	7	100				
4	5	4	115				

Period 3

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
6	8	12	20	4	9	10	10
2	11	7	50	2	11	11	15
1	12	7	55	4	9	10	20
3	12	13	180	5	5	9	5
2	7	7	25	2	11	11	25
5	5	4	50	4	15	14	50
6	8	12	190	2	11	11	55
1	6	7	55	6	8	12	60
3	12	13	200	4	9	6	10
5	5	4	50	1	6	7	30
1	12	13	205				
3	12	13	210				
1	12	13	220				
3	12	13	225				
1	6	7	60				
4	3	6	65				
5	5	4	100				
1	6	7	105				
5	5	4	115				

Period 4

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
1	12	12	200	1	12	12	40
4	7	3	100	5	15	14	45
6	12	9	205	1	12	12	50
1	12	12	210	3	11	11	55
6	5	9	120	1	12	12	65
4	7	3	125	2	6	7	35
6	5	9	130				
4	7	3	140				
6	12	9	215				

Period 5

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
1	5	9	100	3	12	13	40
2	12	10	150	6	15	14	45
5	7	9	105	3	12	13	50
1	5	9	110	6	3	6	10
5	7	9	115	4	7	7	15
1	5	9	120	5	4	3	25
6	15	10	155	6	15	14	55
5	12	9	160				
6	15	10	165				
2	12	10	175				
5	7	9	125				
1	5	9	135				
5	7	9	150				
1	5	9	155				

Experiment 4
ASUM
Period 1

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
2	9	10	50	1	12	13	50
6	9	9	20	6	11	11	55
4	8	10	25	4	12	12	60
1	12	9	110	3	5	4	10
5	6	7	30	6	7	7	15
2	9	10	115	3	5	4	20
1	12	9	120	6	11	11	65
6	9	9	125	4	12	12	75
1	12	13	130				
2	3	6	40				
5	6	7	45				
2	3	6	55				
5	6	7	60				
2	3	6	65				
5	6	7	70				
2	3	6	85				
5	6	7	90				

Period 2

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
1	9	9	100	1	9	11	50
5	12	12	110	3	9	10	20
1	7	7	25	6	12	7	55
6	6	7	30	2	12	13	85
4	5	4	50	6	6	7	10
2	12	13	120	3	3	6	15
5	12	12	130	6	6	7	20
3	15	14	140	3	3	6	50
5	12	12	150	6	6	7	60
6	6	7	60				
4	5	4	65				
6	6	7	70				
4	5	4	90				
3	15	14	160				
5	12	12	170				

Period 3

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
3	12	9	70	2	9	9	10
1	9	10	75	6	8	10	15
3	7	9	75	3	7	9	20
5	5	9	80	1	6	7	30
1	9	10	85	2	11	11	50
3	7	9	85	4	15	14	85
5	5	9	90	5	5	4	60
3	7	9	90				
1	9	10	100				
6	8	10	100				
5	5	9	110				
1	9	10	120				
6	8	10	130				
2	9	9	140				
5	5	9	150				
1	9	10	160				
6	8	10	150				

Period 4

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
2	9	10	50	4	12	13	20
3	9	9	50	3	11	11	25
4	12	9	105	6	5	9	10
1	8	10	10	5	9	6	30
3	11	9	110	6	12	9	70
2	9	10	140	2	6	7	30
1	8	10	115				
4	12	9	170				
6	5	9	120				
1	8	10	130				

Period 5

Market 1 sub	X	Y	Bid	Market 2 sub	X	Y	Bid
3	12	10	125	4	11	11	5
2	12	12	140	1	5	9	0
5	7	9	50	6	9	6	5
1	5	9	100	1	5	9	10
5	7	9	130	3	12	10	10
3	12	10	200	6	15	10	15
2	8	10	140	4	11	11	20
				6	15	10	30
				4	11	11	40
				5	12	9	50
				4	7	7	15
				6	3	10	20
				2	6	7	30